CHEMICAL
& METALLURGICAL
ENGINEERING

Chemistry to Be Represented On Super-Power Survey

THE acceptance by ARTHUR D. LITTLE of an appointment as member of the advisory board on super-power investigations of the United States Geological S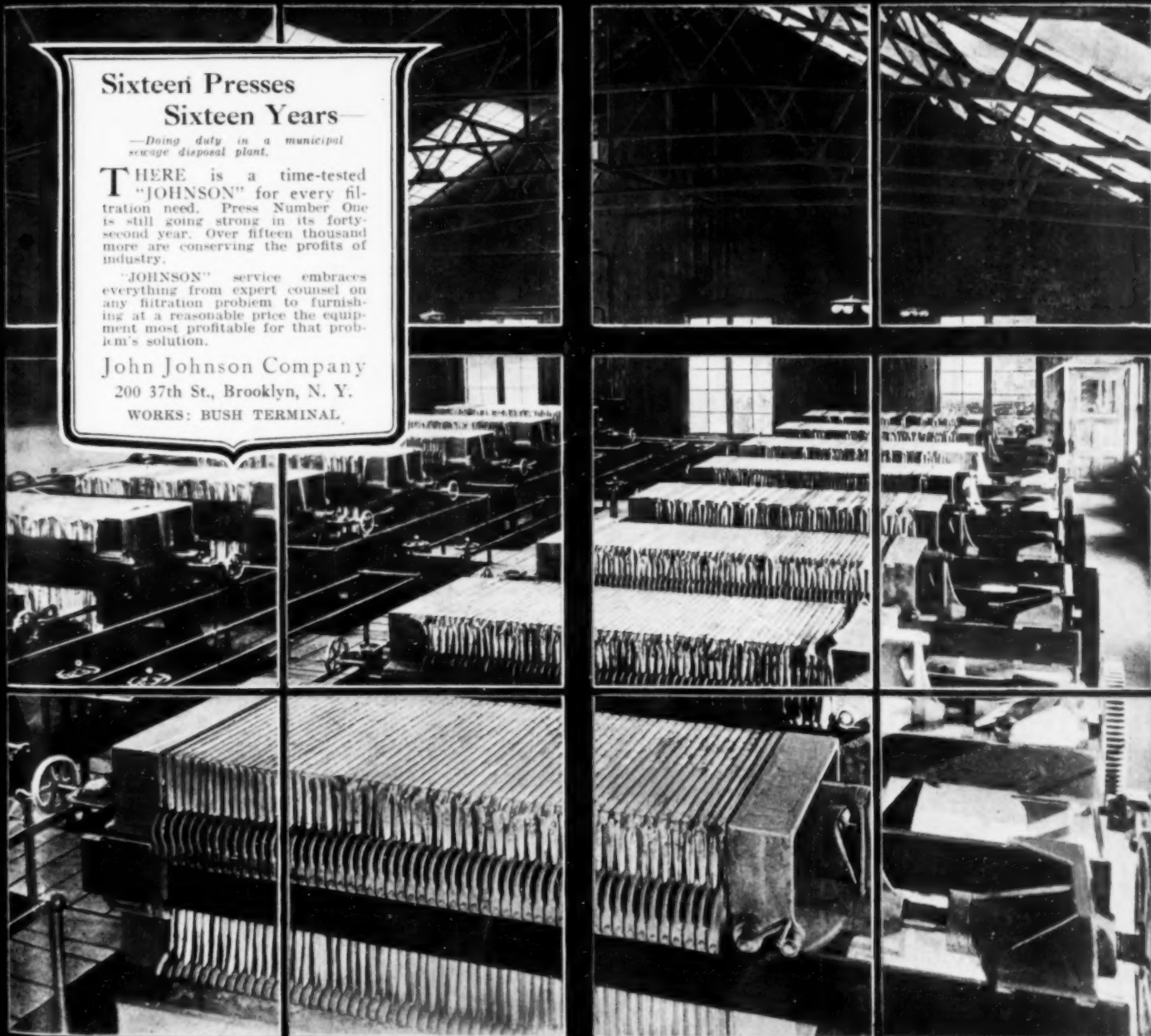urvey will be noted with pleasure by all chemists. CHEMICAL & METALLURGICAL ENGINEERING has urged that the problems of chemistry be carefully considered in connection with these investigations, and it is a great pleasure, therefore, to note this striking assurance that the ideas for which we have stood are agreed to by the Government departments in charge of the work.

The coking of coal and development of byproducts therefrom promises to be one of our greatest chemical industries. Byproduct gas affords a means for transportation of energy from the mine field to the districts where fuel and power are required that does not in any sense interfere with simultaneous transportation of solid fuel by railway and electric current over high-tension power lines. The technology of such gas transfer is well known. It remains to determine the circumstances under which this medium of energy movement is most advantageous.

If gas is used as a medium of energy transfer, the production of byproducts of great value is assured. The chemist is vitally concerned, and chemical industry will watch these investigations with the utmost interest. To be assured that a prominent chemical engineer will be continuously available to advise regarding these problems is most satisfying.

The chemical industries must also be considered by the super-power investigators as important consumers of electric energy. Electrochemical developments afford an excellent supplement for other industrial power requirements, because the load can be so distributed as to make more uniform demand, filling up the hollows and reducing the relative heights of the peaks in the load curve. Chemical engineering attention is, of course, vital for the most advantageous use of this possibility.

Chemistry In the Kitchen

THE chemistry of cooking, so far as its practical application is concerned, is easy. The co-ordination of fats, proteins and carbohydrates into a balanced ration may be learned in a short course in domestic economy, and thousands of young aspirants to the dignity of the distaff in households of the future are studying it in fresh-water and salt-water colleges. How much of it they are learning is open to question. They may take the subject as a thing apart and apply their chemistry to "nutrition," but forget all about it when they think of a feast. The art of cooking is, indeed, much more subtle than the chemistry of ra-

tioning, and while the two are seldom wedded they are, indeed, parts of the whole and should never be separated.

With all the immense sums that we pay for eating we are not very intelligent in the preparation of our food. In an essay lately published in *Harper's Magazine* it was suggested that if a committee of intelligent persons from another planet were to visit the earth for the purpose of reporting on social conditions obtaining among its inhabitants they might well declare to their celestial authorities that, so far as we Americans are concerned, we miss more than is reasonable in the selection and preparation of what we eat. The imaginary high commission noted that, generally speaking, men and women differed in their attitudes toward food, in that men care more for its taste and odor than for its appearance, while women care more for its appearance than for its taste and odor. Nevertheless the preparation of food is assigned chiefly to women. Few women like to cook, and wherever it is possible they employ other women to do the work for them; and these other women have learned what little they know as a trade and not as a science or an art. The kitchen, they observed, is usually placed in the least desirable part of the house, and combined with it in the same room is the scullery, so that all the gross work of cleansing, peeling and cutting up is made part of the cooking, whereby the least agreeable and the most honorable duties of the household are combined in one. Distinction and honor accrue to the art of the cook because what he or she prepares becomes part of our very selves.

One of the reasons why living is so expensive is because competent persons have addressed themselves rather to discrimination in the selection of things prepared than to the selection of things to eat and the subsequent preparation of them. There is so little imagination and invention among cooks that they can make savory dishes only out of certain cuts of meat, while other cuts which cost much less could be made to taste better than the conventional expensive viands with the aid of a little intelligence and imagination. When we consider what the Chinese have done with the soy bean we should hang our heads in shame over our own stupidity with vegetables.

We know a man of science engaged in research whose salary was not increased in accord with the increase in living costs, and the problem of maintaining himself, his wife and four children became a serious one. Fortunately his wife had a scientific turn of mind and had been through a course of "domestic science," so together they began to balance their rations from a chemical standpoint. They prepared the amount actually needed, and found that it was less than had been their custom, and at first they felt themselves on short rations. A few weeks' experience taught them, however,

that they were eating all they needed, and this soon became all they wanted, while the family health improved.

Then came the development of the art as such, the use of herbs, many of which were unfamiliar, a happy diversity of flavors, and a much broader field from which to keep up a constant change in things eaten than before. The result is a complete rationing of the family at no greater expense than before the rise in prices, and with it the greater satisfaction of every member. The man and wife are, it is true, persons of rare and even unusual intelligence, and the results are what we may expect from the application of brains and intelligence to any problem. By thought and experiment they live better today at no greater expense for food than five years ago.

We believe it would pay the proprietors of large hotels and restaurants to retain the services of chemists of the first rank; men of imagination and culture as well as of laboratory technology, to engage in research in the preparation of foods. There are bakery and flour-testing and butter fat laboratories by the score, but these are not what we mean. We have in mind research and development in cooking, which includes baking and frying and broiling and steaming and roasting, with the use of imagination rather than the kitchen conventions in the selection and treatment of raw materials.

Soy Beans and
The Chinese Character

IN THE *National Medical Journal* of China W. A. ADOLPH and P. C. KIANG tell at length of the nutritive value of the soy-bean products, and give information as to their preparation. The leading foods seem to be soy-bean milk, cheese, oil, and sauce. The cheese or bean curd has been the chief source of Chinese protein diet for centuries, and we can commend from experience the excellence of a good chop suey made with it. It is white, has about the consistency of calf's brain, and a delicate agreeable taste. Four methods of making it are given, and when the process involves the coagulation of bean milk with salt bittern, a curd is produced which is rich in all the inorganic essentials that are lacking in the bean proper. The authors suggest that some of the racial characteristics of the Chinese people may be traced to their dependence to so great an extent on this vegetable protein.

If they are right, and if the habits of industry and the disposition to mind his own business that distinguish the Chinaman are due to his diet of soy-bean cheese, let's have more of it in this country. Let's make it by the thousand tons and feed it to the millions.

If our present indisposition to work and our tendency to quit and then blame somebody else for our laziness is due to too much beef and pork and mutton let's give the bean-eaters a chance. Economics is not the main thing in life, and economics alone does not make or mar nations. Dietetics plays an important role. Better far a thousand years of beans than a century or so of too much meat if it is to be followed by collapse. The Chinese dallied with this ubiquitous and excellent vegetable as far back as B.C. 2838. They should have some experience with it by this time, and we have yet to learn of an anti-bean bill in the legislative halls of that country.

Resistance Between
The Cup and the Lip

IN OUR issue of July 28 we published a paper by Dr. ALVIN J. COX on Philippine industrial material, products and resources available to the United States. It was an illuminating catalog of supplies. It showed that the islands offer immense quantities of the following materials, subject, of course, to proper development: Manila hemp, sisal and maguey, tobacco, sugar from cane and palm coconuts, including copra and coconut oil; alcohol from molasses, nipa palm (from which 5,000,000 gallons or 10,000,000 proof gallons are made annually) and from cassava, arrowroot, yams and sugar palm; buri palm fiber for buntal hats which we call "Bangkok" and are so light that whoever can afford to wear them in summer at present high prices will wear no other if his wife will let him; rattans, coir fiber for brushes, ropes and doormats; tree cotton or kapok, which is an oily, short fiber, susceptible to many uses; resins, terpenes, perfumes, edible nuts, and a large variety of vegetable oils; coffee, cacao, papaya gum, strychnine, the leaves and seed of *Datura alba*, which, on extraction, produce a valuable remedy for asthma; rubber, lumber and tanning materials, paper pulp from bamboo (especially *Canabojo*), abaca or Manila hemp waste, rice straw and other paper stock; honey, silk, and a large variety of products of the sea. In minerals there are silver, gold, copper and well-located deposits of iron, the ore being workable, high in iron content and well located. And there is manganese in abundance. The petroleum outlook is very favorable. Coal is imported but is present in large quantities, unmined. Cement material and limestone are plentiful; so are asbestoform materials and so is bat guano. There are resources in fireclay, abrasives and sulphur. There is great need for island-made caustic soda, bleaching powder, lime, sand-lime brick, salt, chloroform and glass, to mention but a part of the list.

'Tis a grand bill of fare, if we, who published it, do say it. If this country were industrially organized the speedy development of many industries would follow. This would add to the sorely needed stores of manufactured materials both here and abroad and bring down the cost of living and of things required in the practice and arts of civilization.

American capital is ready to go abroad and afield, American management in industrial affairs has proved itself as competent as British or German management; in some countries it bears a superior reputation. The trouble seems to lie between knowing that the stuff is there and knowing just how to go about to get it. We need, however, to qualify the statement that American capital is ready to go abroad. It is shy about taking the first step and that is—to pay for *all* the information needed. By far too often it has rushed in—and we lay no stress on Philippine development in this respect—without adequate knowledge. In the islands referred to, for instance, there are great holdings in possession of religious orders, and while these associations are not averse to profits it is necessary to negotiate with them and to understand their points of view and habits of mind. More important still is the industrial survey which, in the making, must be backed by scientific proficiency and acumen, engineering competence in the calculation of costs, as well as in the ability to design and construct, together with keen business common sense and honesty.

Occasionally a technical man is sent out to give a proposal the "once over" and the chances are that he will miss the key to the situation, and then whichever way he decides is likely to be wrong. What is needed is a promotion organization that is in no hurry to make money; the profits of which, beyond costs for services rendered, are to come from industries after they have been established. And such an institution must have modest ideas of bankers' commissions. It requires also better administrative ability than is easy to find, because the diversity of requirements is coupled with the diversity of opportunity.

We believe the best method for such development would be for a kind of organization to be formed between some high-class promotion corporation (and there are a few such) together with selected representatives of such industries as cordage, tobacco, sugar, oil, industrial alcohol, straw hat, furniture, drug, rubber and others, and always including transportation. Competitors are still shy of joint conferences, or of letting one another know what they are doing; and since they will not change their natures it would be better to take them separately. The main thing to pay for would be information, for complete industrial surveys which should be made by the most competent men available. Then the promoting company could coordinate the information, and provide for the mutual aids and conveniences to be enjoyed by the various pioneers. The sugar man and the straw hat manufacturer may not have much in common, and yet they might find themselves indicated as neighbors by the survey.

In short, we should like to see organized research applied to the international and overseas business of the United States.

It would be a great help.

The Right Chain
And the Right Sprocket

USUALLY when a link gives way in a chain drive the plant mechanic hooks in a new one and turns on the power again. If any attempt is made to account for the accident, nine times out of ten it is laid to overloading the conveyor, pump, mixing machine, etc., and to avoid a recurrence the charge to the machine is materially cut down to suit the power delivered by the drive. The lack of good design seldom comes into consideration, probably because very little is known about the subject. General rules are applied, usually, such as: For durability a short pitch is better than a long one; the sprocket centers should not be closer than forty times the pitch of the chain; the under side of the chain should be the slack one; large sprockets and a large number of teeth give less wear; the ratio of sprockets should not be less than 5 to 1 and sixteen teeth should be the minimum used; adjustable shafts should be used to take up wear. But no concrete conception of the phenomena involved is presented.

In printing a Study of Chain Driving in this issue we are making Mr. LAWSON'S article in *Engineering* available to our readers, many of whom have more than a remote interest in this branch of machine elements. Attention is directed especially to the subject of impact and the effect of an oil film on chain elasticity. The formula on the life of chain is ideal engineering computation. It involves the selection of the right chain and the right sprocket.

Pig-Iron Statistics
Are Informing

STATISTICS usually are considered rather "dry," but the statistics of pig-iron production are quite illuminating as to the proportions of the iron and steel industry. The American Iron and Steel Institute has just issued its midsummer pig-iron statistics, showing the production in the first half of this year. The total shown for the output, 18,435,602 gross tons, is one of the least interesting things in the presentation. The trade knew in advance approximately what output would be reported.

As a matter of record, however, it may be mentioned that the maximum half year's output was the 20,826,914 tons made in the second half of 1918, while in the past three half-years output has been as follows: First half 1919, 16,278,175 tons; second half, 14,737,189 tons; first half 1920, 18,435,602 tons. With reference to capacity, under reasonably favorable working conditions, such as obtained in 1916 except for the last two months of that year, the furnaces can probably turn out about 46,000,000 tons of pig iron in a year, so that production in the first half of this year was at 80 per cent of commercial—not rated or theoretical—capacity. That was a good showing considering the great difficulties encountered, particularly in the matter of transportation.

The statistics show that coke is practically the universal fuel in making pig iron. A little bituminous coal is used raw, less than 0.25 per cent of the coke used. A still smaller quantity of anthracite is used, less than 1 per cent of the pig iron having been made with use of any anthracite, and even with that pig iron coke was used largely in mixture with the anthracite. In 1890 2,186,411 tons of pig iron was made with anthracite.

In the first half of this year 155,612 tons of pig iron was made with charcoal as fuel, that being 0.8 per cent of the pig iron output.

Of the pig iron made in the first half of this year 46 per cent was basic iron, while 32 per cent was bessemer and low-phosphorus iron, making 78 per cent for the two "steel-making irons." The comparison is accurate enough, but it is not exact, because on the one hand some of the bessemer iron was produced primarily for making ingot molds, the subsequent use of the worn-out molds in making steel being incidental, while on the other hand in the 22 per cent of "all other" are included spiegeleisen and ferromanganese, which are employed chiefly in steel making. In the year 1907 the production of bessemer iron was more than double the production of basic iron, while in the year 1913 basic iron took first place.

Marketwise, however, the grades of pig iron stand in altogether different relations. Of the total pig iron made, 29 per cent was made for sale, the other 71 per cent being made by consumers. Of the iron made for sale only 20 per cent was basic iron, while only 10 per cent was bessemer and low-phosphorus. Foundry and ferrosilicon comprised 54 per cent while malleable contributed 12 per cent more. No small part of the bessemer, low-phosphorus and basic iron sold was for making steel castings. It may be estimated that of all the "merchant pig iron" made about 80 per cent goes into steel, gray iron and malleable iron castings, including ingot molds, whereas of all the pig iron produced fully 75 per cent is used for making rolled steel.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

London, August 9, 1920.

BUSINESS at the moment is somewhat stagnant, partly owing to the holidays and mainly, perhaps, on account of the serious international situation. Prices of imported chemicals are somewhat higher, but the home chemical trade is dull, with values falling slightly. It is thought, however, that the next month will show a very considerable improvement, especially on export account.

CHEMICAL COMPANIES' RESULTS

Recent reports of progress in chemical undertakings are of a disappointing nature. Thus the dividend on the preference shares of the British Cellulose & Chemical Manufacturing Co. has been postponed, the reasons given being delay in obtaining machinery and plant and the after effects of strikes, etc. It will be remembered that this company is to manufacture artificial silk and "celluloid" products made from acetyl cellulose, and while it is stated that production on a large scale is to commence shortly, the general impression seems to be that the plant has been inefficiently and too lavishly planned and that considerable reorganization will be necessary before remunerative results are obtained. The Alby United Carbide Factories has also failed to declare a dividend owing to shortage of raw materials such as coal and on account of serious losses caused by strikes. The history of the company is a very interesting one and it appears to have been universally successful until it took an interest in the Nitrogen Products Co. with its attendant share manipulations.

An interesting feature of the report is the statement that it is now possible to manufacture carbide on a commercial scale from inferior carbon material using an "agglomerate" patented by the company. Ultimately a committee of inspection was appointed by the shareholders to assist the Board and to watch the shareholders' interests. Brunner Mond & Co. have allocated $400,000 in furtherance of scientific and industrial research, the resolution giving effect to this proposal of the directors having now been carried after it had previously been rejected by the shareholders at the recent annual meeting.

DEVELOPMENTS IN NITROGEN FIXATION AND RUBBER VULCANIZATION

Preliminary details of the Claude process previously referred to have now been published in the *Chemical Age*, London, of July 17, and results of large-scale working will probably be forthcoming before the end of the year. Meanwhile it is understood that the nitrogen fixation process via barium cyanide of the British Cyanides Co. has proved commercially successful and an announcement in this connection is to be made shortly. The chief difficulty seems to have been the question of temperature and suitable refractories for the furnace lining. Similarly, Dr. Calvert's process, which is being developed by the Cyanides Trust, Ltd., was rendered possible only by the use of a new resistant nickel : chromium alloy, "Cronite," and it is understood that while not yet on a commercial scale, manufacture on a large laboratory scale is proceeding with very satisfactory results. An interesting patent is that of Peachey, No. 146,734, for the cold vulcanization of rubber, the process having been developed at the Manchester College of Technology. A company with a capital of $1,000,000 has recently been formed to develop the process, which is somewhat revolutionary in character.

SOCIETY OF CHEMICAL INDUSTRY'S ANNUAL MEETING

In spite of the presumed considerable influx of American visitors to this country at the present time, Americans and Canadians were conspicuous by their absence at this meeting, probably because Newcastle is a relatively long way from London. The conference on filtration promoted by the Chemical Engineering Group disclosed the fact that there is shortly to be an amalgamation of the various interests developing centrifugal filters such as that of Gee and Sturgeon, while the company developing the Sharples centrifuge will probably also be included. The difficulties of continuous operation and of washing the precipitates can be best overcome by such amalgamation and as regards washing, it is probable that the principle of "steeping"— i.e., filling the machine with water to soak into the precipitate—will be adopted. Other interesting features of the meeting were discussions on the increased rate of subscription, the general question of increased publicity and the advisability of forming a British Institute of Chemical Engineers. As regards subscriptions, the point was raised that the interests of American and Colonial members, as well as those of the Society, would be best served by preferential treatment as against British members, while the formation of a British Institute of Chemical Engineers was considered informally, not with a view to separation from the Society of Chemical Industry but to enable chemical engineers to have a voice in the proposed general registration of practicing engineers in this country and to provide facilities for qualifying chemical engineers as and when education in this important subject has been adequately developed. The cinematograph was used for the first time in illustrating one of the papers read before the Chemical Engineering Group, Mr. Kestner, the recipient of the Society's gold medal, being in the chair.

PERSONAL NOTES

Lord Moulton was presented at a dinner held on July 21 with a Georgian loving cup in recognition of his personal and national services, and while his services were really called upon at a time when he "was really too old for his job," there is no doubt that his magnetic personality was the source of inspiration to those who worked under his general direction and that it required a man of his character and achievements to bring about that degree of co-operation among chemical manufacturers which was so lamentably lacking before the war and which is now proving of inestimable benefit to the industry. Dr. T. M. Lowry, F.R.S., has been appointed professor of physical chemistry at Cambridge, G. O. Banister professor of metallurgy at Liverpool University and Dr. R. V. Wheeler to the new chair of fuel technology at the University of Sheffield. The latter's researches in the constitution of coal are classical, while Dr. Lowry's work at the Ministry of Munitions has received full recognition. Sir John Cadman, Director of Petroleum to the British Government, has been appointed a member of the Advisory Council for Scientific and Industrial Research.

Lake Superior Meeting of the A.I.M.E.

Report of the 122d Meeting of the American Institute of Mining and Metallurgical Engineers, Giving Short Descriptions of the Lake Superior Milling and Smelting Practice and of Some of the Papers Presented

LAKE Superior region was the scene of the 122d meeting of the American Institute of Mining and Metallurgical Engineers, their technical sessions starting at Houghton, in the "copper country," just twenty years from the date of their last visit. Over a hundred members of the party had been gathered together since the previous Friday morning on board one of the lake passenger steamers, en route from Buffalo. On this journey the usual pleasures of a water voyage were experienced, ranging from "rubber-neck" wagons at the ports of call to a strong north wind on Lake Huron, either of which was well calculated to disturb the equanimity of the dignified.

That storm so delayed the boat's arrival at Houghton that no inspection trips were possible Monday afternoon, except for those members who had foregathered by rail. Tuesday, however, the Engineers grouped themselves in small parties and were motored over any route which their interests suggested, examining geologic formations, mining methods, surface plants, mill, smelter, refinery or reclamation plant as they desired. Luncheon brought them together at a little bay on the extreme northern end of Kewenaw peninsula, where a picnic full of local color was enjoyed by visitors and hosts. The visitors dissected the anatomy of a "pasty," and enjoyed a four-cornered wrestling bout done in true "Cousin-Jack" manner, while the hosts were able to get impressions of Mr. Hoover from many angles.

VISITORS PROVIDED WITH EVERY COMFORT

Mining men who have acquired tender feet from prolonged use of subways and golfing togs certainly have nothing to complain of the many thoughful attentions given by those in charge of their entertainment in Houghton. Visitors were housed in a rolling hotel composed of Pullman and dining cars, complete enough in itself, but given the finishing touch by the early morning arrival of a road engine, which furnished steam heat and hot water, a comfort well appreciated by anyone who can remember the morning chill in northern woods.

SIGHTSEEING AND SOCIAL EVENTS TAKE PRECEDENCE

Sightseeing and social events took more marked precedence at this 122d meeting than for many past occasions. Relatively few technical papers describing details of local mining and metallurgical operations were read, this deficiency being atoned for by the presentation of a 260-page "Handbook of Mining in the Lake Superior Region," prepared by Alexander N. Winchell, professor of mineralogy, University of Wisconsin, and by the engineers clubs of northern Minnesota and Duluth. Personal inspection also shows improvements in many important operating details, many of which are well worth attention in technical literature. Possibly in no other region could a visitor see Collom tappet jigs and low-pressure steam turbines operating in the same mill, nor a blast furnace making block copper close neighbor to an ammonia leaching plant.

LAKE SUPERIOR MILLING AND SMELTING PRACTICE

Lake Superior milling and smelting practice is distinctly an adaptation to local needs. Primary crushing is done in steam stamps because that is the only high-tonnage machine which will not be "frozen" by the occasional piece of mass copper which slips through. After stamping through ⅜ in. the ordinary practice, as illustrated by the Quincy mill, was to get a little copper by launder jigs before the ¼ or ⅛ in. material (oversize crushed by rolls) was jigged in Collom tappet jigs. The hutch product of these was classified and fed to more jigs, the middlings of which joined the classifier overflows, were settled and cleaned on tables. Such practice —what with the peculiar association of gangue and native copper—gave a recovery of approximately 15 lb. of copper and a tailing of 7.5.

Recent improvements made by Ralph Hayden at this mill have cut the tailing in half, with a corresponding recovery. He substituted real jigs of ample capacity for the "oversize" launder jigs, and sized the roll product so that three separate banks of machines are handling material of certain limiting dimensions. This was in an effort to catch as much mineral in the coarse form as possible, and relieve the machines handling finer products of just that much duty. All jig tailings are then reground in ball mills and passed over a system of primary, middling and cleaning tables.

Older practice at the Calumet & Hecla mill has produced a tremendous volume of much higher-grade tailings than the various amygdaloid ores produce. This is now being reclaimed, reground and settled and the values in the sands leached by ammonia solution,[1] while the slimes are cleaned in flotation machines. This new plant is a model in many ways, and thoroughly in keeping with modern engineering advance.

It contrasts sharply with the primitive 10-ton melting and refining furnaces used to profusion in the smelters. Not that this plant is devoid of improvements, for it has one battery of three large furnaces equipped with every improvement: charging machine, casting machine, pulverized fuel and waste heat boilers. Necessity for keeping various ore receipts separate and the impracticability of accurate sampling have prevented the more widespread installation of modern labor-saving devices. Studies and complete plans have lately been made by the C. & H. staff, working in conjunction with C. H. Repath, involving radical changes in this layout, an improvement which is now held up by unfavorable market conditions. A feature of the new plant will be the separation of the melting from the refining stages—now done successively in the same furnace.

Large reverberatories similar to those in use in Western plants will melt the mineral, delivering practically pure molten copper to the refining furnaces, there to receive the finishing touches.

[1] Process devised by C. H. Benedict (see *Eng. & Min. J.*, July 14, 1917, p. 43), similar to that described in CHEM. & MET. ENG., vol. 20, No. 7, April 1, 1919, p. 328.

On Tuesday, Aug. 24, the party went to Marquette, Mich., and inspected the plant of the Cleveland-Cliffs Iron Co.

The original Pioneer charcoal furnace, the first in Michigan, was built in the City of Negaunee in 1857, and was operated almost continuously until 1895, when it was abandoned. In February, 1890, the Pioneer Iron Co. was acquired by the present owner, the Cleveland-Cliffs Iron Co. This was the beginning of the furnace and chemical department of this company. In 1903 the Pioneer furnace at Marquette was completed and went into blast in connection with the chemical and byproduct plant, and has operated continuously since that time. It is 70 x 13 ft. with a 7 ft. hearth. To supply this furnace with charcoal under normal running conditions, eight acres of hardwood is cut over daily, making about 200 cords of wood. Its capacity is 130 tons of pig iron per day.

In addition to the basic products (methanol, methyl acetone, acetate of lime), the chemical plant produces c.p. acetone, acetic acid, formaldehyde, flotation oils, insulating pitch, sodium acetate, sulphuric acid, iron liquor, methyl acetate, special solvents, hexamethylenamine and pure creosote.

The methanol and acetone are used principally for solvent purposes and in the production of dyes; acetic acid for the cutting of lead, production of vinegar and dyes; formaldehyde as a disinfectant, preservative, treatment of seeds to prevent smut, scale, etc., and in the production of insulating material, such as bakelite, etc. Hexamethylenamine is chiefly used as a drug, largely in cases where internal disinfection is required.

The wood is prepared mechanically, coming in as logs and going through the splitting and block mills, coming out in 8-in. lengths, where it is put into pre-driers, which are heated by the waste gases from the retorts. By this means charcoal can be put in the blast furnace within seven days from the time the tree is cut.

The furnace and also the chemical plant are thoroughly modern. The furnace is equipped with self-dumping device for the charcoal, has steel ore bins, motor-driven scale cars, skip hoist and revolving top.

Technical Papers Presented

SURFACE CHANGES OF CARBON STEELS HEATED IN VACUO

E. HEATON HEMINGWAY and GEORGE R. ENSMINGER described some experiments made at the Watertown Arsenal on "Surface Changes of Carbon Steels Heated in Vacuo." After heating a highly polished piece of 1.01 per cent carbon steel at 1,000 deg. C. for six hours there appeared on the cooled surface, when examined at 500 magnifications, very delicate pearlitic grains outlined by ragged continuous markings, lightly depressed, the whole probably representing the structure stable below the transformation. Clearly independent of these figurings, deeply marked polygonal crystal outlines, with straight elements, represented the gamma boundaries. A third system, suggestive of broad shallow valleys, more or less independent of either, was thought to represent the boundaries of former gamma crystals that have been absorbed by crystalline growth.

This outside layer of carbon-free iron was very thin— a moderately heavy polishing, followed by the usual etching, would exhibit the original hypereutectoid structure. Similar markings remained on lower carbon steels after a similar heating, but in this case the depth of the

pure iron was considerably deeper, although not so deep as found by Rawdon and Scott.[1]

Study of the deposits formed on the inside of the vacuum tube led the present authors to the conclusion that the outside layer containing the characteristic markings consists of a ferrite volatilized at the high temperature and redeposited below the temperature at which solid solution exists. Any iron oxide existing on or in the steel would also tend to cause decarburization by breaking down cementite with formation of corresponding amounts of carbon oxides.

UTILIZATION OF TITANIFEROUS IRON ORE

An interesting paper on "Utilization of Titaniferous Iron Ore," as practiced in New Zealand, was presented by J. A. HESKETT. Large quantities of titanium-bearing iron beach sands are available; these, however, contain large quantities of ferrous oxide. Accepting the established opinion that such an ore would smelt slowly, the author made a mixture of equal parts of the sand and coking coal, coked the combination, producing a ferrocoke having 36 per cent metallic iron and 40 per cent carbon. This was then charged with limestone into a 3 ft. x 8 ft. cupola, and produced ten tons per day of very close-grained gray iron. However, the coke broke up into very fine particles and gradually plugged the furnace.

Briquetting and coking a 1 coke : 3 sand mixture, using sodium silicate for binder, and then smelting with coke and limestone gave no fines and a free-running slag, yet the iron was white. The briquet evidently contained sufficient carbon to deoxidize the ore, yet the time in the coking process (30 min.) was insufficient, resulting in direct reduction immediately above the tuycres at comparatively low temperature.

Using a 45-ft. blast furnace (8 ft. bosh, 4 ft. hearth) with 20-oz. blast at 1,000 deg. F., the charge consisted of briquets containing 50 per cent iron. These were made by grinding eight parts sand and one part coal to an impalpable powder, pressing and carbonizing. Slags were very fluid, but coke consumption was high, and the hearth gradually built up with a mixture of coke, ferro-titanium and cinder. By tapping at short intervals (2 hr.) this high-titanium mixture was flushed out of the furnace between iron and slag. It appeared that approximately 85 per cent of the TiO_2 content in the ore was accounted for as a slag constituent. The remainder was divided, 5 per cent into a high TiO_2 cinder, and the rest in ferrotitanium.

Their experience is that their pig iron will not "grain out" as will other irons of similar analysis. It has a ready tendency to chill to a depth of less than $\frac{1}{32}$ in., even in sand castings, and despite the fact that the iron contains 2.5 per cent Si and 0.04 per cent S. This is usually accompanied, however, by an excellent surface appearance and a strength about 25 per cent higher than expected.

NITROGEN IN STEEL, AND THE EROSION OF GUNS

When studying the structure of failed steel bottles which had contained nitrogen and hydrogen at high temperatures and pressures (in the Haber process), H. E. WHEELER observed a decarbonized inner case, structureless under normal etching agents, and permeated by cracks. Its scleroscope hardness was 20, but a small amount of cold work increased it to 75. Under

[1]CHEM. & MET. ENG., vol. 22, No. 7, April 28, 1920, p. 787.

the microscope no pearlite was evident, although chemical analysis showed from 0.05 to 0.58 carbon, depending upon the alloy steel under examination—chromium-vanadium steel being the most resistant. No satisfactory method for determining nitrogen in this metal was available at the Watertown Arsenal, where the investigation was conducted.

Normalizing at 1,000 deg. C. in vacuo closed the cracks, and caused the reappearance of considerable pearlite in the affected zone, the latter change not occurring if the sample was heated in the air, while the former change was due to relief of internal stresses.

Small cylinders of various analyses were then heated in ammonia for 20 hr. at 650 deg. C. and cooled in the same atmosphere. Nascent nitrogen from such treatment forms Fe_2N, this compound being stable below 450 deg. C. Carburization also occurs in low-carbon irons by pyridine or hydrocarbon impurities in the gas, while decarbonization takes place in hypereutectoid steels. Washed metal is apparently unaffected, while white cast iron becomes coated with solid iron nitride $\frac{1}{8}$ in. deep, a layer easily removed and analyzing Fe_2N plus about 1 per cent carbon. Many alloy steels were studied in this way, and it was concluded that the alloying elements did not combine with the nitrogen, but affected the penetration only as they affected the carbide. Nickel steel, for instance, heated above the critical for 12 hr. gave, when cross-cut, polished and etched, a deep white case, grading into martensite, and thence into a central zone showing pronounced dendritic structure, which latter is reverted to the normal pearlite grains by vacuum treatment. Cold work greatly assists the penetration, the work apparently shattering the cementite so that it is more easily taken and retained in solid solution by the combined action of heat and nitrogen.

These effects were so similar to the oft-described phenomena accompanying gun erosion that Mr. Wheeler proposes a new hypothesis for the cause of this deterioration. Briefly it is that the hard white layer on the inside of an eroded gun is a locally cold-worked (and therefore hard) austenitic case due to penetration of nitrogen at the high pressure and temperature during the course of an explosion.

CASTING AND MOLDING STEEL INGOTS

EMIL GATHMANN presented a brief paper on "Casting and Molding Steel Ingots," in which he classified steel into three divisions: *A*, non-effervescing, killed, or solution steel so made that the lower portion of the ingot is free from blowholes, segregation or pipe: *B*, effervescing gassy or evolution steel, making an ingot containing deep-seated blowholes without pipe or shrinkage cavity; and *D*, a midway class of less commercial importance and ease of definition. Division *A*, comprising only one-eighth the American production, is used for superior-quality material, ordnance, rails, and high-strength materials. *D* cannot be used where surface finish is important. *B* and *D* are usually squared on the ends only, total discard amounting to 20 per cent. Division *A* must be cast big end up to prevent concealed pipe by crystals bridging across the molten center; easy commercial methods for stripping such ingots have been devised, and approximately 1,000,000 tons is made in this manner each year. Killed steel should possess 0.20 residual silicon, while effervescing steel obviously must have silicon and other deoxidizers in very small quantity. When cast properly at low temperature into hot molds, piping steel can be made with only 5 per cent discard.

The molds must have large mass near the base, and be devised so that the top is kept molten to the last, preferably by auxiliary heating.

Type *D* steel cannot be improved by any known mold-design short of fluid compression. Best results in type *B* are had when ingots are bottom cast, although superior results regarding deep-seated blowholes and freedom from "snakes" have been effected by so-called top-bottom casting, where a large volume of very hot steel enters the mold at low pressure and velocity. One large unsolved problem in this type of steel yet remains, however, which is the prevention, or rather reduction, of segregation.

NOTE ON PRO-EUTECTOID FERRITE

When studying the structure of a cast-steel runner (0.35 per cent C, 2.69 per cent Ni) CHARLES V. CLAYTON noted a peculiar occurrence in the pearlite kernels. Ordinary reticular structure was observed at low power, but on higher magnifications the very fine, almost sorbitic pearlite granules exhibited white ferrite markings arranged like Widmanstättian bands ordinarily, but often as swirls or rosettes.

The author supposes that a whirling motion in the liquid steel rounded the tips of dendritic branches, upon which low-carbon austenite would be precipitated, due to the selective freezing or differential crystallation noted by Foley,[2] which upon passing the transformation range would give birth to the bent ferrite plates.

Variation in Length of Wood Fibers

A new conception of wood fibers is given by the great number of measurements that the Forest Products Laboratory in Wisconsin has made. The length of the fibers, instead of being uniform and characteristic in each species, has been found to vary more in a single tree than in the average for different species. One Douglas fir had fibers ranging from 0.8 to 7.65 mm. in length, though several thousand measurements showed the average for the Douglas fir to be 4.41 mm. and for the long leaf pine 3.76 mm.—a difference in the average for the two species of less than 1 mm., or one-twenty-fifth of an inch. In early growth, up to twenty to fifty years, the fiber length increases strikingly from the center outward, but after the maximum has been reached the variation is small, even though the tree live to 400 years or more. There is also some increase in fiber length from the butt of the tree upward for about two-thirds of the distance to the top. Each annual ring shows variation, the wood of early spring having longer fibers than that formed last in summer.

Develop Bonding Clays

Blends of bonding clays for use in crucible manufacture, which have been in process of development at the Ceramics Station of the Bureau of Mines at Columbus, Ohio, have reached a point where the Bureau is confident that the entire sufficiency of domestic clays has been proved. Since bond clay must possess a variety of properties, such as plasticity, bonding strength, slight shinkage and a tendency not to slag, no one clay has been found entirely adequate. Requirements for all uses are being met, however, by the blends which are being developed. A number of domestic clays have been developed which have been found to be superior to the clays imported before the war.

[2]CHEM. & MET. ENG., vol. 22, No. 3, Aug. 1, 1919, p. 140.

Convertion of Walnut Shells Into Poultry Charcoal in a Rotary Kiln

BY HARRY L. GLAZE and RAYMOND B. STRINGFIELD*

TO CONVERT walnut shells, a waste product, into poultry food, a salable commodity, seems at first glance a difficult problem, but in reality it is quite simple. The solution of the problem brought out several features capable of rather wide application.

Briefly, the problem was this: From the walnut crop of southern California there are produced many tons of nuts which are scarred or otherwise off grade. These were formerly discarded or sold for next to nothing. With the development of a cracking machine, the meats from the cull nuts were made to yield a profit, but there remained as a waste product a thousand tons or more of shells per year. These were expensive to handle and bulky to dispose of. Used as a fuel, they proved to be unsuitable when burned loose, and were difficult to briquet. The available tonnage was too small to permit of the profitable operation of a retort process for the production of charcoal, acetic acid and creosote. Several attempts made to develop a profitable outlet for the shells had proved unsuccessful.

Upon investigation it was found that many tons of willow charcoal were brought into southern California each year to supply the large poultry ranches; it was also found that walnut charcoal was even better than willow for this purpose. Experience with the incineration of kelp in a rotary kiln for the recovery of its potash content convinced the authors that charcoal could be produced economically in a similar type of apparatus, and operation of the completed installation proved this surmise to be correct.

DESCRIPTION OF PLANT

The feature of the installation is its extreme simplicity resulting in low power and labor costs. Incoming shells from the walnut cracking plant are fed into the hopper of a No. 2 Sprout-Waldron corn grinder, the hopper being set flush with the unloading platform. The grinder reduces the shell to approximately 4 mesh, with the production of very little dust and fines. The product weighs about 31 lb. per cu.ft. A bucket elevator delivers the ground shell to a storage bin of five tons capacity. The bin has a 45 deg. hopper bottom, closed by an adjustable vertical gate, through which a reciprocating slide feeds a regulated quantity of ground shells into the kiln at each revolution.

The kiln is a steel shell 20 in. in diameter and 19 ft. long, lagged on the outside with asbestos felt 1 in. in thickness. This is mounted on trunnions and has a slope of 1 ft. in 10. There is a special arrangement of lifters and baffles designed to secure agitation of the shells during charring. It has been found that proper agitation is especially important, as it was almost impossible without it to control the conditions of charring. A chain drive rotates the kiln at 10 r.p.m. The regulated discharge from the storage bin flows into a hopper from which it is fed into the kiln by a rotary scoop such as is commonly used on ball mills. Through an 8-in. hole in the center of the scoop pass three 1½-in. ordinary type gas burners. These have atmospheric mixers and ⅝-in. openings and burn 3 cu.ft. of gas per minute each.

*Mechanical and chemical engineers, Arthur R. Maas Laboratories.

As the ground shells enter the kiln, they pass through the flame and into a zone of high temperature. Active decomposition begins immediately and is accompanied by the complete combustion of the dust formed in grinding. About 6 ft. from the inlet end of the kiln an exorthermic reaction sets in, the burning ceases and energetic distillation takes place. This is accompanied by dense clouds of creosote-bearing smoke. In the last few feet, distillation is completed, and the thoroughly charred shells are cooled. The charcoal discharges into a hopper and is quenched by a water spray. From the hopper it is conveyed to a rotary screen yielding 4-, 6- and 10-mesh products, which are sacked. The product is of excellent quality, free from dust, and of slightly higher gas-absorbing power than ordinary willow charcoal. The yield is slightly over one ton of charcoal per three tons of shells.

The flue gases are blown by means of a 10-in. fan into a scrubber, where practically all of the tar and creosote is removed by means of sprays. About 40 lb. of tar is recovered per ton of shells. The tar is suitable for use as a timber preservative. On distillation it yields excellent grades of creosote, heavy oil and pitch. No attempt is made at present to recover the acetic acid and other soluble constituents of the spray water.

COST OF OPERATION

The plant has proved simple and economical to operate. The feed is easily regulated and the shells are thoroughly charred without ashing. The grinder can be so regulated that practically the entire product is between 4 and 10 mesh. A 10-hp. motor furnishes ample power, drawing only about 4 hp. average load. Four men operate the plant—one per shift, with an extra man on the day shift to sack charcoal and do repair work. The chief source of trouble is the flue connecting the kiln with the scrubber, which catches considerable tar and burns out occasionally, making it necessary to clean out the flue every few days.

The plant has a capacity of three tons of shells per 8-hr. shift, yielding slightly over three tons of finished charcoal per twenty-four hours. Neglecting overhead and the cost of shells, the present cost of operation is:

Capacity:
Twenty-four hr. operation, 18,000 lb. shells, 6,000 lb. charcoal
Operation Cost per Day:

Three men at $5	$15.00
One man at $4	4.00
Gas at $1 per ton of shells	9.00
Electricity at 6c. per kw.-hr. for 4 hp	4.56
Water	1.50
	$34.06

Cost per Ton of Charcoal:

Operation	$11.35
Sacking at 20c. per sack	4.00
Cartage on 3 tons of shells	3.00
	$18.35

Since poultry charcoal is selling on the Pacific Coast at $50 per ton and up, it will be seen that the plant is a profitable venture, even neglecting the value of the tar and creosote recovered as a byproduct.

Test runs have been made on apricot, peach and prune pits and on ordinary sawdust and shavings, and excellent results have been obtained in each case; the charcoal, of course, varies with the raw material. As the initial cost of the equipment is low, this type of plant with its flexibility and small operating cost may solve the waste disposal problem of other industries, even of those operating only a few months in the year.

Los Angeles, Cal.

Chicago Meeting, American Ceramic Society

Abstracts From President Minton's Remarks on His Investigations of the Economic Situation of the Ceramics Industry and Business Conditions in Germany—Short Notes on the Visits to Some Chicago District Industrial Plants

THE summer meeting of the American Ceramic Society, in accordance with the usual custom, followed a program of inspections of manufacturing plants, no papers being presented. The opening feature was the banquet at the Hotel LaSalle on Monday night, Aug. 16.

W. D. Gates, the dean of Chicago ceramists, presided at this function. Secretary Binns and Mr. Gates, charter members of the society, indulged in reminiscences of former times to the delight of the guests.

The chief address was delivered by President Minton, who had just returned from an extended trip through Germany investigating the ceramic industries and business conditions. His remarks covering general conditions are given in brief below.

PRESIDENT MINTON'S ADDRESS

"My journey was by way of England and Holland to Berlin, thence to Essen, Cologne and the Rhine cities. I found conditions very bad, the food supply being inadequate with nothing but black bread and potatoes available in the smaller cities. At the large hotels in principal centers there is plenty of food at fabulous prices, which accounts for the optimistic reports of some travelers. Everything is issued on cards as during the war and 100 g. of bread per person is the daily allowance. Importation of other than gift food is not allowed by the authorities, who are desirous of conserving the supply of available cash. Some food is smuggled in through Coblentz, as no frontier is recognized and consequently no inspectors are in evidence at this point. There are 550,000 children being fed by the German Government. These are on the average two years under size for want of proper nourishment.

"The economic situation is exceedingly bad. Transportation equipment is particularly depreciated. Every car in Germany has a flat wheel. Upholstering has been ripped from the car seats to be used for clothing. This is also true of household furniture. I did not see any of the paper suits in evidence, but paper belting is being used in factories and is said to be as efficient and long lived as leather belting.

"I visited twenty-seven clay plants and three chemical plants during the period. The Krupp works at Essen employ about 38,000 persons engaged in manufacture of typewriters, sewing machines and similar peace-time products. Many ceramic plants are burning wood for fuel. All are operating at about 50 per cent capacity because of lack of fuel.

"The attention paid to detail in these industries is remarkable. Clays are floated in order to segregate the finest material and classify the remainder. One plant is using the ultra-violet rays over the clay solutions to kill the bacteria which would otherwise exert action to collect the iron particles and subsequently speck the wares.

"Several companies are engaged in making large quantities of stove tiles, a business entirely ignored in America. These artistic tile stoves are lined with refractory materials which hold the heat in the room. The tiles are pressed very soft in aluminum molds, insuring perfect cast pieces."

PLANT INSPECTIONS

Chicago industrial plants were visited as outlined below. The Western Electric Co. gave a complimentary luncheon on Tuesday and the Chicago Hardware Co. entertained the members in like manner on Wednesday.

BACH BRICK CO.

This plant is a typical example of distinctive methods employed in the manufacture of common brick in the Chicago district. The clay from the pits contains from 8 to 14 per cent combustible matter, and coal dust is sometimes added to assist in the burning. The clay comes from the cutter with practically no previous working, is stacked on iron cars and put through the waste heat driers. The cars are then run out to an open area, where the overhead crane with special hoisting grapples lifts the mass of brick from a car in one

operation and transfers it to the huge rectangular pile. Large quantities are stacked in a short time; the outside of the pile is walled over with a layer of burned brick and mud; oil burners are inserted in eyes near the bottom and the burning operation started. The finished brick are loaded directly from the pile to wagons and cars.

NORTHWESTERN TERRA COTTA CO.

This manufacturing plant involves methods of procedure combining the skill of artist and scientist to produce commercial wares. It is a huge art studio em-

FIG. 1. PARTLY FINISHED ORIGINAL DESIGN FOR THE WRIGLEY BUILDING, CHICAGO

ploying numerous designers and clay modelers on one hand and demanding application of the exact science of chemistry to finishing glazes on the other. This is immediately evident in the fact that 35,000 tons of clay is molded to special shapes each year. No stock pieces or molds are kept. Each order calls for new designs. And the glazes used require all the colors of the spectrum with all the infinitely delicate shadings and blendings so essential for an appeal to the artist's eye. Here the ceramist is in his glory.

The raw clay is brought in from the Indiana coal district by rail and mixed with suitable grogs depending on the ware desired. The clay sculptor with the aid of architect and pen artist produces the original design from which plaster of paris molds are made; these molds are sent to the casting room, where the required number of pieces are cast. Then the finishers tool out the imperfections by hand and work the finer clay to the surfaces.

The drying is carried on in ten Carrier Engineering Corporation chambers, where the air is conditioned from a temperature of 130 deg. F. and a relative humidity of 70 at the start to a temperature of 180 deg. F. at the finish. Taylor Instrument Co. instruments are installed for the proper control of the driers.

The glazes are sprayed on in some instances, but a large amount of work is done with the brush.

A spacious ceramic laboratory is equipped to control the scientific features and prepare new glazes. Fig. 2 shows an Isko refrigerating machine used for freezing a piece in the laboratory. When this is thoroughly chilled it is removed and subjected to a steam bath on one side and protected with an ice bath on the other—a rigorous test of glazes against climatic conditions. Abbe mills are used in preparing the glazes.

The burning operations employ thirty-five periodic kilns of the muffle type and eleven days is required for the burning cycle. Maximum temperature of about

1,050 deg. C. is reached. In addition a 320-ft. Dressler tunnel kiln has just been installed, increasing the capacity of the plant about 50 per cent. This kiln continuously turns out about eighteen industrial cars of ware per day and burns oil for fuel, reaching a temperature of 2,100 deg. F. in the hot zone. The estimated efficiency of fuel consumption is 75 per cent, against 10 per cent efficiency in the periodic kilns. The waste heat is conveyed overhead to the Carrier driers.

LINDSAY LIGHT CO.

The production of gas mantles from oxides of cerium and thorium nitrates burned to oxides is carried on after the method of the Welsbach Co. of Philadelphia, which was described in detail in the Oct. 15, 1919, issue of CHEMICAL & METALLURGICAL ENGINEERING, page 497. The monazite sands from Brazil are passed through an electro-magnetic separator to remove the iron and thence to the digesters, continuing through the same process as the Welsbach, with slight modifications.

COONLEY MANUFACTURING CO.

The production of enameled kitchen ware in this plant involves two distinct departments, namely, the fabrication of the metal shape, involving punching, drawing and annealing of sheet steel to shape, and the application of the enamel or "granite" coating to the piece. The first department is a series of large machine shops with a variety of presses and continuous annealing furnaces arranged to anneal the metal between drawing operations. Rapidly operated electric spot-welding machines are employed to attach handles and lugs to the various utensils.

The enamels are prepared dry in a battery of Abbe mills and subsequently mixed with water in the tanks
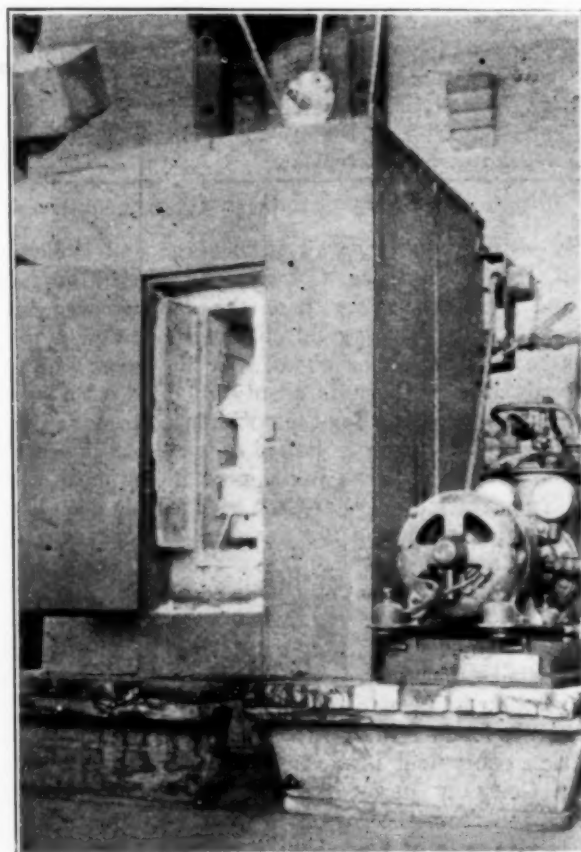

FIG. 2. TESTING GLAZE BY FREEZING

at the dipping benches. Women are employed for the dipping room work, which is done by hand. The mottled effect on granite ware is obtained by throwing a second color on with a coarse stipple brush and turning the piece in the hand while the splotches are still wet. Various trimming coats are given by brush or dipping.

The ware is placed in movable racks, which are later wheeled to the drier. The burning on is accomplished in a short space of time by introducing into coal-fired muffle kilns and removing almost immediately. Though most of the coating operation is hand work, the production is enormous.

The company is erecting a large steel and brick building which when equipped will double the plant's capacity.

WESTERN ELECTRIC CO.

Some idea of the extent of this mammoth Chicago concern may be gathered by an inspection of the power house which generates 150,000 kw. from steam turbo-generators. An increased capacity to a total of 200,000 kw. will be available when the new General Electric turbine goes into service. The total factory space is 3,000,000 sq.ft., devoted entirely to the manufacture of telephone equipment. There are 22,000 employees engaged in turning out 100,000 telephones per month, 400,000 switchboard lines per year of central office equipment and other commercial systems. The work is particularly rushing at this time due to the change over of the entire Bell telephone system to automatic central station control, which requires new apparatus with the present system maintained in operation during the period.

The cable plant turns out 250,000,000 conductor ft. of telephone cable, or 98 per cent of all the telephone cable produced in America.

The visitors were provided with a sufficient number of guides to give one guide to each four men—quite a departure from the ballyhoo usually attempted. Space will not permit an adequate description of this trip, but should manufacturers in general organize inspection trips as the Western Electric did in this instance the educational benefit to visitors would equal many months of study and be of inestimable value in our industrial development.

AMERICAN STEEL & WIRE CO.

This factory, like the Western Electric Co., conducts operations on an enormous scale. Billets 4 in. x 4 ft. of high- and low-carbon steel are received from the mills of the Chicago district as raw material. These are heated in furnaces and rolled to rods about ⅜ in. in diameter which are handled as coils of wire. After pickling in muriatic acid and neutralizing with lime solution, they are annealed and ready for the drawing operations.

The company makes fence wire, copper, zinc and tin finished fine wire, wire fence, springs of all sorts, wire nails and baling wire. An interesting feature of the drawing operation is the use of a fermented rye meal solution for lubricating the wire just before it enters the dies. Details of the chemical control will be presented in a subsequent issue of CHEM. & MET.

CHICAGO HARDWARE CO.

This plant produces small castings and white glass table tops. It is the most successful manufacturer of small iron castings in the Chicago district and has an elaborate department for making small and intricate cores.

After an evening at the outdoor opera in Ravinia Park, the meeting was concluded. The Chicago Section's hospitable entertainment was deeply appreciated by the visiting members.

Canada's Sugar Industry

There are three sugar plants in the Province of Ontario, two in Quebec, and one each in British Columbia, New Brunswick and Nova Scotia.

The amount of capital invested in the industry in 1918 for the whole of Canada was $37,256,851, apportioned by items as follows: Land, buildings, and fixtures, $17,733,990; machinery and tools, $6,108,445; materials, stocks in process, finished products, fuel, and miscellaneous supplies on hand, $6,511,626; and cash, trading and operating accounts, and bills receivable, $6,902,790. The capital invested in Ontario plants was $11,407,382; in Quebec, $5,869,592; and in the remaining provinces, $19,979,877.

The quantity and cost value at the works of the material used during 1918 are shown below:

Classes of Materials	Tons	Cost Value at Works
Beets	204,017	$2,593,715
Raw sugar	313,651	39,991,144
Bone black and other materials		529,059
Boxes, bags, other containers		2,289,119
Total cost		$45,403,037

The quantity and selling value at the works of the various products are shown in the following table:

Kinds of Products	Quantity	Value
Sugar, granulated, pounds	651,940 965	$57,080,353
Molasses or sirup, gallons	1,559,694	1,016 626
Beet pulp, tons	11,069	411,645
Lime, bushels	22,590	6,250
Fertilizers, tons	1,284	43,075
Cattle food		151,776
All other products		102,494
Total value		$58,812,219

"Colloiditis" Prevalent in Britain

FROM OUR LONDON CORRESPONDENT

London, August 9, 1920.

The use of the word "colloid" is at present being made an excuse and a catchword in the chemical industry and elsewhere, the uninstructed public having heard so much recently of progress in colloidal chemistry that any new project connected or presumably connected with it attracts undue attention. Even in the realm of "colloidal" fuel methods in which the fuel and oil are merely blended without the aid of a peptizing agent are being exploited by companies under names such as the Colloil Trust. Dr. Searle's recent book on "The Use of Colloids in Health and Disease" also suffers from the craze of applying the term "colloid" indiscriminately and the book was trenchantly and amusingly criticised in the *Journal of the Society of Chemical Industry* of June 30, p. 211R, by Dr. H. H. Dale. Thus Dr. Searle states that all products of digestion are essentially colloidal and, after previously stating that solutions of colloids do not pass through membranes, assumes that in the presence of common salt their passage is considerably increased. From this Dr. Searle deduces "the advisability of eating salt with so typical a colloidal gel as a boiled egg," but to quote Dr. Dale's criticism, "if salt will get a boiled egg through the alimentary mucous membrane, digestion becomes a mere hobby."

Program of Chicago Meeting, American Chemical Society

THE following is the final program of the general meeting, entertainment, industrial excursions and Industrial, Rubber, Fertilizer and Leather Divisions:

Monday, Sept. 6

4 p.m. Council meeting in Parlor B, University Club.

6:30 p.m. Councillors' dinner given by Chicago Section in College Hall, University Club.

8 p.m. Council meeting reconvenes in Parlor B.

Tuesday, Sept. 7

10 A.M.—GENERAL MEETING, GOLD ROOM, CONGRESS HOTEL

Address of welcome by Prof. Julius Stieglitz, honorary chairman, in behalf of Chicago Section.

Address of welcome by Joseph R. Noel, vice-president of Chicago Association of Commerce, in behalf of Chicago business men.

Response for Society by Prof. William Albert Noyes, president American Chemical Society.

"The Value of Technical Training in the Reconstruction of Industries," by Thomas E. Wilson, president Wilson & Co., packers.

"Chemistry's Contribution to the Life Sciences," by Dr. A. S. Loevenhart, University of Wisconsin.

The directors of the Chicago Chemists' Club will entertain the directors and the advisory committee of the American Chemical Society at luncheon, club headquarters, 315 Plymouth Court.

The Association of Harvard Chemists will meet in the Green Room, Congress Hotel, for luncheon and the semi-annual meeting.

1:15 p.m. Take special elevated trains at Adams St. Station for Noyes St., Evanston. Badge admits to trains.

3 p.m. General meeting reconvened in Patten Gymnasium, Northwestern University campus, Evanston.

"The Relation of Educational Institutions to the Industries," by Prof. H. P. Talbot, Mass. Inst. of Tech.

"Some Uses of Silica Gels," by Prof. W. H. Patrick, Johns Hopkins University.

ENTERTAINMENT PROGRAM

4:30 to 7:30 p.m. Chicago Band concert on the campus.

4:45 to 5:30 p.m. Swimming exhibition in gymnasium pool.

5:30 to 6:30 p.m. Swimming in pool for men only. No suits required.

4:45 to 5:45 p.m. Organ recital in Fisk Hall by Hugo Goodwin.

5 to 6 p.m. Indoor-outdoor baseball game between Chicago section and the World. Captain—Chicago Section, L. V. Redman; the World, Charles H. Herty.

5:30 to 7:30. Dancing in the gymnasium.

4:45 to 5:30. Committee of Evanston women headed by Mrs. L. V. Redman and Mrs. W. Lee Lewis will serve punch at various stands on the campus.

6 to 7 p.m. Supper served on the lawn south of the gymnasium near the Shakespeare Gardens. Registrants are furnished with tickets.

4:30 to 7:15 p.m. Outdoor smoker.

7:15 to 9:30 p.m. Evening entertainment.

8 to 10:30 p.m. Observatory will be open for inspection of the universe.

Special trains start for the city from Noyes St. at 9:40 p.m., but regular trains run all night.

Wednesday, Sept. 8

DIVISIONAL MEETINGS, 9 A.M. AT UNIVERSITY OF CHICAGO

Copy of the *Chemical Bulletin* furnished to all registrants will give explicit directions for reaching this and other locations.

DIVISION OF INDUSTRIAL AND ENGINEERING CHEMISTRY

Session opens with a symposium on "Cellulose Chemistry," which will be led by Dr. J. J. Esselen of A. D. Little, Inc.

"The Constitution of Cellulose," Harold Hibbert.

"Economics of the World Pulp Situation," Hugh P. Baker.

"The Regeneration of Book Stock," Charles Baskerville and Clarence Joyce.

"Recovering of News Print," Charles Baskerville and Reston Stevenson.

"On the Cellulose Content of Certain Compound Celluloses," Louis Kahlenberg.

"A Comparison of Wood Cellulose and Cotton Cellulose," S. A. Mahood and D. E. Cable.

"Acid Hydrolysis of Sugar Cane Fiber and Cottonseed Hulls," E. C. Sherrard and G. W. Blanco.

"The Preparation and Analysis of a Cattle Food Consisting of Hydrolyzed Sawdust," E. C. Sherrard and G. W. Blanco.

"Supply and Preparation of Wood for the Manufacture of Pulp," Hugh P. Baker.

"Parchmentizing Paper and the Reaction of Mordants," J. E. Minor.

"Is It Feasible to Form a Section of Cellulose Chemistry?" G. J. Esselen, Jr.

"Solvents for Phosgene," Charles Baskerville.

"Electrometric Method for Detecting Segregation of Dissolved Impurities in Steel," (Lantern), Edward G. Mahin and R. F. Brewer.

"Soda-Lime for Industrial Purposes" (Lantern), Robert E. Wilson.

"Flow of Viscous Liquids Through Pipes" (Lantern), Robert E. Wilson and M. Seltzer.

"New Solvents for Rosin Extraction," H. K. Benson and A. L. Bennett.

"Comparative Study of Vibration Absorbers," H. C. Howard.

"Catalysis in the Manufacture of Ether," Hugo Schlatter.

"Use of Platinum Crucibles in Electro-Analysis. Copper Determination," Harold Van Doren and J. R. Withrow.

"Use of Platinum Crucibles in Electro-Analysis. Rapid Copper Determination," Rufus D. Rud and James R. Withrow.

"Estimation of Benzene in Admixture With Paraffine Hydrocarbons," H. McCormack.

"Preparation of Manganates and Permanganates," H. McCormack.

"Permanganate Determination of Sulphur Dioxide," H. S. Coith and James R. Withrow.

"Action of Permanganate Upon Sulphur Dioxide and Sulphides," F. C. Vilbrandt, Samuel L. Shonefield and James R. Withrow.

"Idiometric Determination of Sulphur Dioxides," Gordon D. Patterson and James R. Withrow.

"Uniform Packages for Reagent Chemicals," W. D. Collins.

"Uniform Specifications for Chemical Thermometers," R. M. Wilhelm.

"Recovery of Industrial Gases With Activated Charcoal," O. L. Bannebey.

"A Comfortable Dust Respirator," H. V. Main.

"Evidences of Auto Catalysis in the Hydrogenation of Cottonseed Oil," O. R. Sweeney and Joseph Elbert.

RUBBER DIVISION PROGRAM

Discussions, "Shall the Rubber Division publish an annual volume of reprints and lengthy abstracts of interest to the rubber chemists and the public during the year?"

W. B. Weigand, "Rubber Energy."

Research Laboratories, New Jersey Zinc Co., "The Aging of Some Rubber Compounds."

Research Laboratories, New Jersey Zinc Co., "Some Microsections Cut From Vulcanized Rubber Articles."

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PATTON GYMNASIUM
NORTHWESTERN
UNIVERSITY

A. S.
LOEVENHART

G. D. Kratz, A. H. Flower and B. J. Shapiro, "The Action of Certain Organic Accelerators in the Vulcanizing of Rubber (II)."

G. D. Kratz, A. H. Flower and B. J. Shapiro, "The Action of Certain Organic Accelerators in the Vulcanizing of Rubber (III)."

J. F. Schufter, "Method for the Determination of Free Sulphur and Antimony Tri- and Penta-Sulphides in Golden Antimony."

J. B. Tuttle, "The Action of Heat and Light on Vulcanized Rubber."

Symposium, "The Analysis of Rubber," led by W. W. Evans.

Round table discussion of recent developments.

There will be samples on exhibition of rubber, vulcanized by Peachey's nascent sulphur method.

FERTILIZER DIVISION

"Kelp as a Basis of an American Potash Industry," J. W. Turrentine.

"Relationships of Chemistry and the Fertilizer Industry," C. H. MacDowell.

"A Perfect Fertilizer Law," E. G. Proul.

"Boron in Relation to the Fertilizer Industry," J. E. Breckenridge.

"The Quantitative Estimation of Borax in Mixed Fertilizers," J. M. Bartlett.

"Note on the Determination of Nitrogen in Fertilizers Containing Both Organic and Nitric Nitrogen," by F. B. Carpenter.

"Injurious Effects of Borax on Field Crops," F. B. Carpenter.

"The Changes Taking Place in Cyanamide When Used in Mixed Fertilizers," Rolla N. Harger.

"Dicyanodiamide. A Rapid, Direct Method for Its Determination in Cyanamide and Mixed Fertilizers," Rolla N. Harger.

"Some Results of Determination of Potash by the Lindo-Gladding Method of Using Alcohol of Various Strengths in the Presence of Sodium Salts," R. D. Caldwell and H. C. Moore.

"The 'Blank' in the Kjeldahl Process, Its Analytical and Commercial Significance," B. F. Robertson.

LEATHER SECTION

"Nature of the Hide-Tannin Compound and Its Bearing Upon Tannin Analysis," John Arthur Wilson and Erwin J. Kern.

"The Mechanism of Bating," John Arthur Wilson.

"Chemical Control of the Tannery," F. C. Orthmann.

"A New Method for the Recovery of Nitrogenous Fertilizer Material From Tannery Waste Sulphide Liquors," V. H. Kadish.

"The Influence of Acids on the Tannin Content of Tan Liquors," Alan A. Claflin.

"On the Swelling and Falling of White Hide in Vegetable Tan Liquors," George D. McLaughlin and R. E. Porter.

"Dyestuffs as Used in the Leather Trade," P. R. Roberts.

"The Effect of Concentration of Chrome Liquors in the Adsorption of Its Constituents by Hide Substance," A. W. Thomas and Margaret W. Kelly.

"The Determination of Hydrochloric Acid and Neutral Chlorides in Leather," A. W. Thomas and A. Frieden.

"Comment on Wilson and Kern's Recent Contribution to the Knowledge of Vegetable Tanning Agents," A. W. Thomas.

Luncheon arrangements have been made at the Edelweiss Gardens during the scientific meetings.

PLANT VISITS

1:15 p.m. Entrain at Van Buren and Randolph Stations, Illinois Central R. R., on special train, or catch same train at 57th and 60th St. stations at 1:30.

Doehler Die-Casting Co., maker of aluminum and white metal castings.

Pullman Car Works. Freight and assembly plants, where the "Ford plan" produces one every few minutes.

Sherwin-Williams Co. Visit the Dutch Process White Lead plant.

Carter White Lead Co. Making white lead by Carter process.

Libby, McNeill & Libby, Blue Island Cannery. Packing jelly, jam, mustard, olives, apple butter and catsup.

SOCIAL FEATURES

6:30 p.m. Alpha Chi Sigma fraternity dinner at Hotel Morrison.

8 p.m. "Chemical Publications," by President W. A. Noyes, Gold Room, Congress Hotel.

Thursday, Sept. 9

DIVISIONAL MEETING, UNIVERSITY OF CHICAGO

9 a.m. to 12 noon and 2 p.m. to 5 p.m. Division of Industrial and Engineering Chemistry will hold a Fuel Symposium arranged by A. C. Fieldner, Pittsburgh Station, Bureau of Mines, as follows:

"Low-Temperature Carbonization of Coal," S. W. Parr, University of Illinois; T. E. Layng.

"Carbonization of Canadian Lignite," Edgar Stansfield, chemist, Canadian Department of Mines.

"Efficiency of Various Fuels for Heating Houses," Henry Kreisinger, fuels engineer, Bureau of Mines.

"Byproduct Coking," F. W. Sperr, Jr., chief chemist, Koppers Company.

"Relation of Byproduct Recovery to Fuel Utilization and Economy," C. E. Lewers, Semet-Solvay Co.

"Use of Charcoal in the Extraction of Gasoline From Natural Gas," G. A. Burrell, president, Island Refining Co.

"Colloidal Fuels, Their Preparation and Properties," S. E. Sheppard, chemist, Eastman Kodak Co.

"Gasoline Losses Due to Incomplete Combustion in Motor Vehicles," A. C. Fieldner, supervising chemist, Bureau of Mines; G. W. Jones; A. A. Straub.

"The Enrichment of Artificial Gas by Natural Gas," J. B. Garner, Peoples Gas Co., Pittsburgh, Pa.

"Commercial Realization of Low-Temperature Carbonization of Coal," Dr. Harry A. Curtis, chief chemist, International Coal Products Corporation.

"Fuel Conservation, Present and Future," Horace C. Porter, consulting chemical engineer.

7 p.m. Semi-annual banquet, Gold Room, Congress Hotel. Evening dress optional. Tickets to registrants, $4. Toastmaster, W. Lee Lewis. Speeches and music.

Friday, Sept. 10

INDUSTRIAL EXCURSIONS

Illinois Steel Co., South Works, blast furnaces, bessemer converters, electric furnaces, open-hearth furnaces, rolling mills and gas-engine plant operating on cleaned blast-furnace gas. Train leaves Randolph St., Illinois Central R. R., at 8:19 a.m. and Van Buren St. at 8:20 a.m.

The following trip which includes plants listed below starts from the LaSalle St. Station from 8:10 to 8:27 a.m.

Albert Schwill & Co., maltsters.

. American Maize Products Co., maker of cornstarch and byproducts therefrom, corn oil, dextrose, dextrin, glucose, etc.

Steel & Tube Co. of America, operator of Semet-Solvay byproducts coke plant and large tube mill.

American Steel Foundries Co., Indiana Harbor plant, maker of steel castings.

International Lead Co., electrolytic refiner of lead and electrolytic white lead.

Assemble at Congress Hotel at 1:30 p.m. for the following excursions:

The Fleischmann Co., maker of cider vinegar, malt vinegar, white wine vinegar and yeast.

National Malleable Castings Co., malleable iron castings.

Northwestern Terra Cotta Co., terra cotta and art decorations.

Fansteel Products Co., maker of pure tungsten and molybdenum.

Sears, Roebuck & Co., wallpaper and color plants. Leave at 1 o'clock and have luncheon at plant.

Heath & Milligan Co., manufacturer of pigments and mixer and grinder of paint.

Legal Notes

BY WELLINGTON GUSTIN

Seymour Mfg. Co. Obtains Large Judgment— Agreement Not in Restraint of Trade

The $180,296.63 judgment in favor of the Seymour Manufacturing Co., of Seymour, Conn., against the Derby Manufacturing Co., of Derby, Conn., has been set aside by the Supreme Court of the state, for the purpose of correcting numerous errors, thereby changing the judgment, though such change is not substantial in the amount.

The case is involved, arising out of contract between the companies for the manufacture of copper bands for projectiles. The Derby company, with the financial aid of the Seymour company, built a plant adapted to the manufacture of these bands, and began operations with orders turned over to it by the Seymour company. It also attempted to go into business on its own account, but was unable to finance the purchase and carrying of copper, and turned to the Seymour company for assistance. The contract in question was entered into Jan. 29, 1917, and was terminated April 20, 1917, by mutual consent. At this latter date the Derby company was indebted to the Seymour company. The judgment was obtained by Seymour and Derby appealed. A number of questions arising out of the business relations of the parties were presented to the Supreme Court.

QUESTION OF LEGALITY OF THE CONTRACT

The first question was whether the contract was illegal on its face or because it was entered into for the purpose of restraining competition. It purported to be a contract to co-operate in the construction of copper driving bands on the basis of the Seymour company providing the copper and the Derby company manufacturing the bands therefrom. Each party engaged to fully inform the other of any impending business, and if it is proposed to bid for or accept any such business, and if the Seymour company can furnish the copper, and the parties agree on the market price of the copper and on the contract price for the bands, then the Seymour company is to make the bid or acceptance in its own name, and turn over one-half of the tonnage orders so taken to the Derby company for production. The Derby company agrees to take the Seymour company's copper, use it and to account for the scrap. The difference between the market price of copper per pound and the contract price of bands per pound is called the "toll" in the contract, and is to be divided in proportion of eleven parts to the Derby company and four parts to the Seymour company.

DEFENDANT CLAIMED RESTRAINT OF COMPETITION

Defending the suit, the Derby company claimed that this contract was illegal as restraining competition because the parties proposed to agree on the price of bands. The Supreme Court said this contract contained no present agreement on prices for any purpose. Though it does contain an agreement to agree on the price at which some bands shall be sold, this is not for the purpose of preventing one party from underselling the other in the open market. It relates only to orders or contracts brought within the contract by the specific agreement of the parties in each case; and therefore applies only to orders which must be or may be, according as the contract is construed, turned over in part to the Derby company for production. Of course, said the court, the Derby company cannot bid against the Seymour company for any contract and at the same time agree to act as its bailee for hire in assisting to fill it. But this does not make such illegal at common law or under the Sherman anti-trust act.

The Derby company further contended that the contract is illegal because it agreed not to make any bid or take any order for bands. But the court failed to find anything in the contract prohibiting the defendant Derby company from accepting business on its own account. The contract goes no further than to provide that, so far as the parties may be able to agree on prices, the Derby company is to co-operate in production, and the bid or acceptance is to be in the Seymour company's name. It must follow, said the court, that if the parties cannot agree on the price at which any order will be accepted for co-operative production, either party may compete for it on its own account.

The claim that the contract was entered into for the purpose of restraining competition between the parties is refuted by the findings of the court that the Seymour company did not have productive capacity to fill its orders, and that the Derby company had surplus capacity for production, but did not have the funds or credit enough to carry on the business on its own account.

MINOR ERRORS IN THE JUDGMENT

There were numerous minor errors in calculating the amount of the judgment. The Derby company reported that it had made 288,283 bands under the contract. In making these it used not only the 500,000 lb. of copper furnished by the Seymour company at the agreed special prices, but also used 180,499 lb. of other copper belonging to Seymour, which was in the Derby company's possession. Acting on the theory that the Seymour company was bound to furnish copper for 500,000 lb. in bands at the specified prices, it credited the Seymour company with 30.5c. only for this copper, although its market value when appropriated was 35c. a lb. Defendant appropriated the plaintiff's copper to the contract without agreeing on its price, and the plaintiff relied on the implied promise of the defendant to pay what the copper was reasonably worth. The court said the copper was reasonably worth its market value at the time it was taken.

Again, one order, known as the "Chase contract" was to be carried out by the Derby company shipping and billing the bands direct to the Chase company, and reporting to the Seymour company the number of bands so shipped and paid for. There was an option in the "Chase contract" calling for an additional quantity of bands. The Derby company concealed the fact that the option had been exercised. It failed to report 73,830 bands which were delivered to the Chase company and paid for. Now, the Seymour company did not furnish the copper for these unreported bands, but it was at all times ready and willing to do so. The Chase contract was a co-operative transaction. The court said the Seymour company had the right to assist in its performance by furnishing the copper at agreed prices and the right to receive its agreed toll on all bands delivered and paid for. Conversely the Derby company had no right to resort to other sources of copper supply in order to make itself the sole beneficiary of the con-

tract. The Derby company claimed the agreed toll was payable only in case the Seymour company furnishes the copper. But the answer is that the latter's readiness and willingness to furnish copper is in law a sufficient performance of its agreement to furnish it, as against the defendant who has wrongfully prevented it from doing so.

Another important element of the case was the special damages claimed by the Seymour company in the delay of returning the copper scrap to it at the termination of the contract. The court held the Derby company was liable for the loss to plaintiff by its being compelled to buy additional copper through this delay in returning the copper scrap.

Court Holds Invention by Employee Not Within His Contract Assigning All Invention Rights

The White Heat Products Co. sought to compel its employee Charles W. Thomas to disclose certain inventions and assign to it an application for patent on such devices, pursuant to the terms of a written agreement between the parties. The case was heard before a referee, who found for the products company, holding that the invention was within the terms of the contract. After argument the trial court reversed the finding of the referee and dismissed the company's case, and now the Supreme Court of Pennsylvania has affirmed this decision.

The White Heat company is described as being organized for the purpose of making and selling products from silica and other materials, and at time of entering into the contract with Thomas it was engaged in the manufacture of bricks for wainscoting, etc., from white silica rock mixed with glass as a binder. Thomas was an expert in matters of this character and owner of certain patents, and, in consideration of the agreement of employment, assigned to the company all his interests in certain specified patents, together with the exclusive right to make, use and sell the design under another patent relating to a furnace "in so far as the same relates to the business of making bricks, stone products, earthenware products or analogous and collateral products," together with his "entire right, title and interest in and to every invention, interest therein, or claim thereto relating to the manufacture of bricks, stone products, earthenware products, and analogous and collateral products which he now has or may hereafter make or acquire during the period of his employment by said stoneworks and for one year after the termination thereof."

WORKED ON ABRASIVE WHEEL INVENTION

For a period of two years and ten months Thomas continued experiments in the manufacture of bricks and all patents secured by him were assigned to the White Heat Products Co. In 1914, the company's plant being idle owing to its operations proving unsuccessful, Thomas began of his own accord experimenting with a process for making an abrasive wheel to be used for grinding iron, steel and other hard metals. The experiments were at first conducted in a separate shop, but later the matter was discussed with P. M. Sharpless, president of the White Heat company, with a view to their engaging in business together, and it was agreed that experiments be continued at the company's plant and at its expense. The experiments proved successful and samples were put on the market.

Agreement over the manufacture of abrasive wheels was not concluded and the company then first claimed the invention was within the original contract of employment.

The first question presented to the Supreme Court was, Is a wheel used for grinding an invention "relating to the manufacture of bricks, stone products, earthenware products or analagous and collateral products" within the meaning of those words as used in the contract? Its answer was that it was not such an invention.

AGREEMENT MUST BE CLEAR AND UNMISTAKABLE

The rule of law is that in cases of this kind, where the product of an inventive mind is sought to be appropriated under an agreement to assign to another, the language of the agreement must be clear and show an unmistakable intention that the particular matter covered by the invention or patent is within the intention of the parties at the time of agreement.

The court said that measured by this rule the contract as viewed by the company falls down. It is as susceptible to one construction as another. The court was of the opinion that the contract provisions were limited to inventions relating to the manufacture of earthenware products and do not apply to or require the assignment of patents for the manufacture of all articles made of earth or clay; consequently a tool in the nature of an abrasive wheel, although composed principally of bauxite clay, is excluded from its terms as not coming within the meaning of the words "earthenware products."

There is another rule of law that where a person in the employ of another devises a new invention and uses the property of his employer and the services of other employees to put the device in practical form and assents to the use of the perfected invention by his employer, he thereby gives to such employer an irrevocable license to use the device. This was urged in favor of the company.

But the court said it did not apply, since the invention was conceived and the preliminary work done outside of the employee's working hours and in a plant not connected with his employer's plant. While the article was subsequently perfected and manufactured in the plant of his employer, still this was done under and subject to the completion of negotiations for a proper compensation to Thomas through the profits to be derived from the manufacture and sale of the patented article.

Judgment was therefore affirmed against the company.

Contract Where "Ton" Means 2,000 Lb.—Rule May Be Changed by Agreement or Custom

In an action by the Chemung Iron & Steel Co. against the Mersereau Metal Bed Co. on a sales contract in New York, the court there construed the term "ton" as used in the contract to mean 2,000 lb. and not a long ton of 2,240 lb., where the contract called for "tons" merely and not long tons and neither by proof of trade customs nor otherwise was it shown that long tons were intended. In the circumstances, section 4 of the General Business Law must be held to govern. It reads in part: "The hundredweight consists of one hundred avoirdupois pounds, and twenty hundredweights are a ton." And where there is no agreement to the contrary, or a general custom of the trade does not change the rule, same must be applied.

A Study of Chain Driving

Report of Investigation and Tests on Chain Driving — Variable Factors Involved — Some
Mathematical Relationships—Effect of Impact on Life of Chain
—Economic Calculations

F. M. LAWSON has made notable progress in the development of a chain driving theory in his recent contribution to *Engineering*, July 2, 1920, which, on account of its interest to the engineering profession, we are reproducing in full:

To a commercial mind, perhaps the first appeal of any proposition in engineering is with regard to the practical issues which are likely to result from its direct application. The commercial mind is not so much concerned with the theories involved, but prefers to examine them in the light of actual practice. The true theorist, on the contrary, prefers to commence from first principles, adopting as his base a point as in Euclid. From this beginning he sets down his proposition and deduces the facts which may be inherent although not always self-evident. He is content that the theory shall be subjected to the most careful scrutiny in its smallest detail, and is not satisfied unless the test of actual practice be applied in order that his conclusions may be proved to be sound.

TWENTY VARIABLE FACTORS

Research work connected with chain driving is undoubtedly difficult, since in any chain drive there are at least a score of variable factors, the alteration of any one of which may involve alteration of several others. The following gives twenty variable factors: (1) Number of teeth in wheels; (2) revolutions per minute of wheels; (3) ratio of reduction; (4) inclination of drive; (5) material wheels made of; (6) steadiness of load; (7) speed of chain; (8) pitch of chain; (9) lubrication of chain; (10) pull on chain; (11) center distance; (12) inclination of chain; (13) type of chain; (14) design of chain; (15) length of chain; (16) tension on slack side of chain; (17) bearing pressures; (18) weight of chain; (19) accuracy of manufacture of chain; (20) accuracy of manufacture of wheels.

Looking at the above list, it will be observed that if one factor is altered and a different result obtained it will be impossible to say whether the difference is due to the original factor being altered or to one of those factors which is affected by its alteration. For instance, increasing the number of teeth in a driver wheel may give a longer life, but is this longer life due entirely to the number of teeth being altered? Is it not also due to the fact that by increasing the number of teeth the pull in the chain is decreased and the bearing pressure reduced? Or, again, would not the life have been increased still further if the alteration had not affected the speed of the chain?

Tests would have to be carried out *ad infinitum* to establish any definite theory, which in itself is an absurdity, so that if any theory can be outlined which will enable those engaged on practical research to direct and concentrate their energies along defined paths their time will be saved and progress made.

Now, to follow in Euclid's footsteps, what is the point common to all chain drives?

In considering a chain drive the simplest form may be stated to consist of a driver wheel, a driven wheel, and a length of endless chain, the utility of the chain being to transmit power from the driver wheel to the driven wheel. The chain consists of a series of links connected by studs, so that the center of all studs in the chain travel along the same path; consequently if the path of one stud can be definitely located, the paths of all studs at any position in the chain drive are located, and this stud path in its relation to the wheels is common to all chain drives and consequently may be considered as the starting point, for it is a line generated by a point.

Now a stud in a chain 1-in. pitch running at 500 ft. per minute moves a pitch length in $\frac{1}{100}$ second, so that it is impossible to see the path of any one stud although the light wave of the path of all studs may be observed under favorable conditions. The practical value of this light wave cannot be exaggerated, but it has one drawback for research in that it is not capable of measurement, and consequently a method had to be adopted to obtain actual stud paths at high speeds which could be measured. The method the author adopted, and it is a method which has the advantage of being simple, is as follows:

To one of the studs in a chain a stiff pointer was fixed extending about ⅜ in. beyond the width of the chain. When the chain was running a board covered with beeswax was moved toward the chain so that the pointer scratched the path in the wax. In order to simplify the mechanism, records were taken separately at four different places:

(1) Entering the driver wheel; (2) leaving the driver wheel; (3) entering the driven wheel; (4) leaving the driven wheel.

In this paper the author has concentrated on the first division, knowing that if this is solved the three remaining divisions can be solved in the same way. Before dealing with these practical results it is necessary to investigate the theory, for, although chain drives have been on the market over thirty years, no satisfactory theory has yet been published, so far as the author knows, and consequently the following is the result of research:

MATHEMATICAL RELATIONSHIPS

The "true" pitch circle diameter of a wheel may be calculated from the formula:

$$\text{Pitch circle dia.} = p \operatorname{cosec} \alpha \text{ inches} \qquad (a)$$

where p = pitch in inches

Tr = number of teeth in driver wheel (or driven wheel Tn),

and $\alpha = \dfrac{180}{Tr}$.

The speed in feet per minute on any point on the pitch circle is equal to:

$$\frac{\pi p N \cos \alpha}{12} \text{ feet per min.} \qquad (b)$$

Where $N =$ revolutions per minute

If the chain is running toward the wheel the "straight" speed is equal to:

$$\frac{pNTr}{12} \text{ feet per min. or } \frac{180pN}{12\alpha} \text{ feet per min.} \qquad (c)$$

It must be noted that the speed (b) is always greater than the speed (c) since the linear measurement of the circumference of the "true" pitch circle is always greater than the linear measurement of a polygon composed of Tr sides of length p. Or expressed otherwise:

$$\text{Speed } (b) : \text{speed } (c) :: \alpha : \frac{180}{\pi} \sin \alpha \qquad (d)$$

and α is always greater than $\frac{180}{\pi} \sin \alpha$
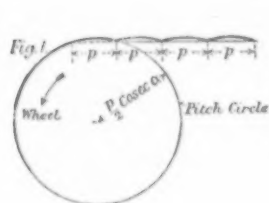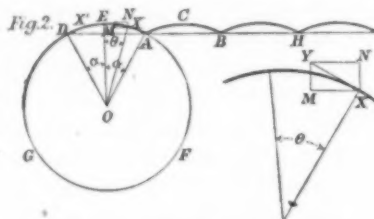

FIG. 1. PITCH CIRCLE   FIG. 2. HORIZONTAL AND VERTICAL VELOCITIES

At first sight there appears to be a difficulty in accounting for two speeds because the center of one stud may be traveling circumferentially at a higher speed than the center of a stud behind it, which is traveling in the straight line. It is accordingly necessary to analyze the straight speed and see what is meant by this.

Firstly at dead slow speed it is obvious that the path of a stud traveling toward the driver wheel is composed of arcs of the "true" pitch circle, the chord of the arc being equal to p, see Fig. 1. (For convenience these arcs are afterward referred to as "pitch arcs.")

Take the case of a wheel which is traveling without cyclic variation; the speed at any point on the arc is constant. In Fig. 2, let

$$EFG = \text{pitch circle}$$
$$DA = \text{pitch} = AB = BH.$$

The velocity at any point X in the pitch circle may be resolved into horizontal and vertical velocities—the horizontal velocity being proportional to XM, the vertical velocity proportional to XN, when XY represents the velocity at the point X which may be found from formula (b).

Hence $XM =$ horizontal velocity at point X.
$$= XY \cos MXY.$$
$$= XY \cos \theta, \text{ where } \theta = XOE.$$
And $XN =$ vertical velocity at point X.
$$= XY \sin MXY.$$
$$= XY \sin \theta.$$

Now XY from formula (b)

$$= \frac{\pi p N \cos \alpha}{12} \text{ feet per min.}$$

Hence horizontal velocity at any point X

$$= \frac{\pi p N}{12} \cos \alpha \cos \theta \text{ feet per min.} \qquad (e)$$

And vertical velocity at any point X

$$= \frac{\pi p N}{12} \cos \alpha \sin \theta \text{ feet per min.} \qquad (f)$$

It follows that the horizontal velocity at the point A, where $\theta = \alpha$

$$= \frac{\pi p N \cot \alpha}{12} \qquad (g)$$

which, when α is acute, is always less than speed (c).

And since (c) is always less than speed (b), which is the horizontal velocity at the point E, there must be some point between A and E at which the horizontal velocity equals speed (c). To find it:

Let X be the point.

The horizontal velocity of $X =$

$$\frac{\pi p N}{12} \cos \alpha \cos \theta \text{ by } (e)$$

and the speed (c) is $\frac{180 p N}{12\alpha}$

These are equal if $\pi \cos \alpha \cos \theta = \frac{180}{\alpha}$

$$\text{or } \cos \theta = \frac{Tr \sin \alpha}{\pi} \qquad (k)$$

The various values of θ for different values of Tr are given in Table I.

TABLE I.		
Tr	θ	Log Cos θ
10	10 deg. 22.86 min.	9.9928325
15	6 deg. 54.84 min.	9.9968303
30	3 deg. 27.82 min.	9.9992060

The value of having located the point X by knowing the angle θ is that this point may be known as the point at which "action" commences, or in other words the point at which the horizontal speed of the pitch circle path begins to get greater than the straight speed of the chain.

In order to simplify reference to this point later it appears advisable to give some definition to the portions of the arc AED.

Let AX be termed the period of inaction,
  XE be termed the period of action,
  EX' (where $EX' = EX$) be termed the period of reaction,
  $X'D$ be termed the second period of inaction,
where X is located by the angle EOX whose cosine $=$

$$\frac{Tr \sin \alpha}{\pi}.$$

POINT OF IMPACT

It is obvious that the point A on the pitch circle may be accepted as the theoretical point of impact.

In Fig. 3, AK represents the direction of pull of chain at point A and AL represents the direction of pull from wheel at point A.

The pull $AK =$ pull AL. Hence impact pull AJ must be such as will make AL the resultant of AK and AJ.

Now

$$\frac{AJ}{2} = AL \sin \alpha$$

or

$$AJ = 2AL \sin \alpha$$

Now, if AK, which $= AL$, $=$ pull on chain, the vertical impact blow must be equal to

$$2f \sin \alpha, \text{ where } f \text{ is the pull on the chain} \qquad (m)$$

Table II gives values of vertical impact blow for various numbers of teeth, when the speed is such that the point of impact is the point A.

TABLE II

Tr	Impact in Terms of Pull
6	pull × 1.0
9	pull × 0.684
10	pull × 0.618
12	pull × 0.518
15	pull × 0.416
18	pull × 0.347
20	pull × 0.313
30	pull × 0.209
45	pull × 0.134
60	pull × 0.105
90	pull × 0.067

WHAT HAPPENS DURING THE PERIOD OF "ACTION" AND "REACTION"

The period of action commences at a point X, which is found by the angle θ being known from formula (k), i.e.,

$$\cos \theta = \frac{Tr \sin \alpha}{\pi}$$

So, since the total period of action and reaction: arc $AED :: \theta : \alpha$ it follows that between X and X^1 the chain in the straight will have traveled a horizontal distance

$$= \frac{\theta}{\alpha} p \text{ inches} \qquad (o)$$

and between X and X^1 the wheel will have traveled a horizontal distance

$$= \text{chord } XX^1$$
$$= 2XO \sin \theta \text{ in.}$$
$$= p \text{ cosec } \alpha \sin \theta \text{ in.} \qquad (p)$$

Consider two studs (n pitches apart) in a chain—the forward is engaged for action at X and the back one is traveling a distance $= np$ behind it. At high speed, in the majority of cases it can be proved from the stud path tests that the path of a stud in the straight is
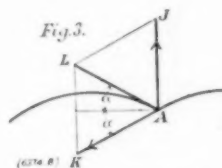
FIG. 3. CHAIN FORCES

straight. Hence the forward stud will travel a horizontal distance given by (p), while the back stud travels a horizontal distance given by (o). Also

$$\frac{\text{the distance } (p)}{\text{the distance } (o)} = \frac{p \text{ cosec } \alpha \sin \theta}{\dfrac{\theta p}{\alpha}} = \frac{\dfrac{\sin \theta}{\theta}}{\dfrac{\sin \alpha}{\alpha}}$$

Now $\frac{\sin \theta}{\theta}$ is known to decrease as θ increases.

Hence the distance (p) is greater than the distance (o).

Consequently a certain amount of elasticity is called for in the chain between the forward stud and the stud n pitches behind it when the stud path of the latter is straight. The measurement of this elasticity may be found by subtracting the distance (o) from the distance (p). Or elasticity required during period of action and reaction

$$= p \text{ cosec } \alpha \sin \theta - \frac{\theta p}{\alpha} = p \left(\frac{\sin \theta}{\sin \alpha} - \frac{\theta}{\alpha} \right) \qquad (q)$$

when θ is given by

$$\cos \theta = \frac{Tr}{\pi} \sin \alpha$$

and

$$\alpha = \frac{180}{Tr}$$

The various values for varying numbers of teeth, when $p = 1$ in., are given in Table III.

TABLE III

Tr	p In.	$\left(\dfrac{\sin \theta}{\sin \alpha} - \dfrac{\theta}{\alpha} \right)$
10	1	0.00640
15	1	0.00283
30	1	0.00070

Or, when θ and α are small, this formula (q) may be written:

Elasticity required during period of action and reaction

$$= \frac{0.64p}{Tr^3} \qquad (r)$$

HOW DOES IMPACT AFFECT LIFE OF CHAIN?

Damage done by impact may be considered under two headings:

1. Invisible damage, such as fatigue of material.
2. Visible damage, such as the loss or malformation of metal from the tooth of a wheel, back of liner, face of silent link, surface of roller, etc.

These two types of damage at first sight involve complications in arriving at a life formula. If, however, a chain drive has a reasonable factor of safety the invisible damage or fatigue of material does not exist as a potential factor, but it is undoubtedly the factor which comes into evidence when tests are carried out under abnormal conditions such, for instance, as a life test on a chain with a factor of, say, 4 on a 15-tooth wheel running at a high speed. On such a test as this the chain fails after a few hours through fatigue of material, and the test is consequently almost valueless for commercial purposes, since few, if any, drives fail in this way, and those which do fail may be due to other causes, such as a low factor having been created by an excessively tight chain. In other words, these tests are similar to Wöhler's researches, which proved that parts subjected to variations of stress for long periods must be provided with a higher factor of safety than parts subjected to a steady load.

Hence for practical purposes damage which is only visible under the microscope may be overlooked, but it must not be forgotten when complaints arise, since it is then a potential factor.

Visible damage creates malgearing, and the greater the damage the greater the malgearing, and consequently the greater the impact. Summing this up, it appears as if damage accumulates at compound interest—thus, if a chain has increased in pitch 1 per cent during five years it will certainly have increased more than 2 per cent in ten years, and may quite conceivably have increased 2 per cent in six years. This compound interest may possibly be reckoned as constant for one type of chain, but the constant is hardly likely to be the same for a roller chain as for a silent chain; moreover, it may vary with the pitch of the chain. There appears at present to be no method of arriving at this constant except by the lengthy process of testing.

Some useful purpose will be gained by arriving at a comparative life formula for any one chain with varying numbers of teeth in the wheels. Such a formula will be useful in determining the commercial value of the number of teeth in a wheel.

Damage done per minute to the studs is proportional to the impact blow $\times$ number of times it occurs per minute.

$$= 2f \sin \alpha \times NTr, \text{ using formula } (m).$$

N being the r.p.m. and f the pull on the chain.

Life of the chain varies as

$$\frac{Number\ of\ studs}{damage\ per\ min.\ to\ the\ studs}$$

If $L =$ length of chain, number of studs $= \dfrac{L}{p}$

$\therefore$ Life of chain varies as $\dfrac{\frac{L}{p}}{2f \sin \alpha\, NTr}$

$$= \frac{L}{2fpNTr \sin \alpha}$$

Now the drive is given, $\therefore f \times$ speed of chain is constant

$\therefore \dfrac{fpN}{12} Tr$ is constant, using formula (c)

$\therefore$ Life of chain for a given drive varies as

$$\frac{L}{\sin \alpha} \text{ where } \alpha = \frac{180}{Tr} \qquad (s)$$

EXAMPLE

A 10-hp. drive, 600 r.p.m. to 200 r.p.m., centers 4 ft., chain 1 in. pitch. Which drive is the best commercial proposition, the drive arranged with $15T$ and $45T$, making the cost of the drive $100, or a drive having $20T$ and $60T$ costing $120. Length of chain for the $15T$ drive, say, 126 in. Length of chain for $20T$ drive, say, 136 in.

Life of $15T$ drive : life of $20T$ drive :: 126 cosec 12 deg. : 136 cosec 9 deg. :: 603 : 870, making commercial value of life $100 : $145, whereas cost of $15T$ drive : cost of $20T$ drive :: $100 : $120.

Hence the $20T$ wheel drive is a better commercial proposition.

It must, of course, be borne in mind that there is a limit to the number of teeth which can be used, for, when a chain wears, it gets out of gear quicker with a large wheel than a small one.

This question of damage by impact opens up a strong case for small wheels being of the same hardness as the portion of the chain which engages with the wheel.

Thus in the case of roller chain wheels with only a few teeth, these should be hardened, since the roller of

TABLE IV. TESTS CARRIED OUT AT THE WORKS OF MESSRS. HANS RENOLD, LTD., MANCHESTER

No.	Type of Chain	Pitch of Chain, In.	Tr	Tn	R.p.m.	F.p.m.	Pull	Approx. Hp.	Centers In.	Lubrication
1	Roller	1	17	17	1,000	1,420	230	10	Long	None
2	Roller	1	17	17	1,000	1,420	230	10	30½	Oiled
3*	Roller	1	17	17	1,000	1,420	230	10	30½	Oiled
4	Roller	1½	10	30	450	560	...	...	45	Oiled
5	Roller	1½	10	30	900	1,125	...	...	45	Oiled
6	Roller	1½	10	30	1,200	1,500	220	10	45	Oiled
7	Roller	1½	10	30	1,200	1,500	...	...	45	Oiled
8	Roller	1½	10	30	900	1,125	73	2½	45	Oiled
9	Silent	1½	15	54	1,200	2,250	36	2½	45	Oiled
10	Silent	1½	15	54	900	1,700	48	2½	45	Oiled
11	Silent	1½	15	54	450	850	96	2½	45	Oiled
12	Silent	½	15	15	1,040	650	920	18	...	Oil pump

*In test No. 3 the point was attached to the rear stud of outside link. In all other cases it was attached to forward stud on outside link.

the roller chain is hardened, but in the case of small wheels for chains in which unhardened links engage with the wheels, it is probably sounder policy to have a mild steel wheel unhardened.

Mention has already been made of the method adopted to record on wax the actual path of a stud. Particulars of a few of these tests are given in Table IV, and the salient points reproduced in Table V.

Tests 1, 2 and 3 may be grouped and termed lubrication tests, since the only altered factor between Nos. 1 and 2 was oil, and between Nos. 2 and 3 the only

TABLE V
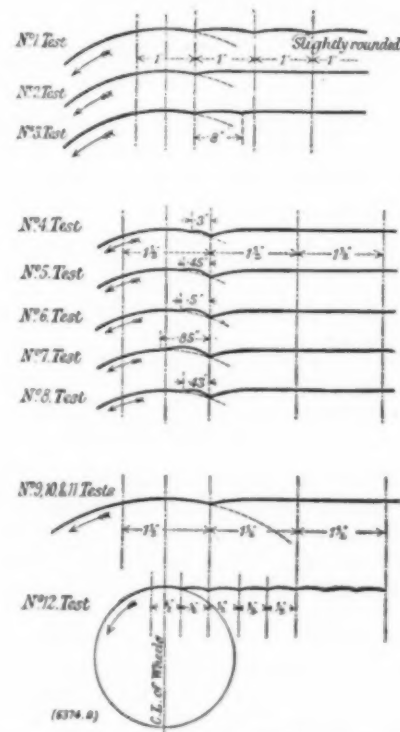
alteration was that the chain was reversed so that the point scribed the path of the stud at the rear end of the outside link.

Much valuable information can be obtained from these three stud paths. In the first place (test 2) the stud path leading up to the wheel assumed a straight line when the chain was oiled, whereas when the chain was bone dry (test 1) the path showed a series of arcs with slightly rounded joints. Secondly, when the pointer was placed on the rear stud of the outer link (test 3) the path showed a straight line finishing off with one arc before entering the wheel.

The only possible explanation for the difference in path before and after oiling lies in the theory that lubrication supplied the necessary elasticity. Formula (*r*) gives the necessary elasticity in this case to be 0.0022 in.—which elasticity in test 2 might be provided by oil in any one of the following four places:

(*a*) Between tooth of wheel and roller of chain.

(*b*) Between roller and bush.

(*c*) Between bush and stud in engagement.

(*d*) Between bush and stud behind engagement.

Thus it appears that each film of oil supplied 0.0006 in. of elasticity.

In order to test if this theory was correct, test 3 was tried, since lubrication could not affect the rear stud path of an outside link when this was one pitch in distance
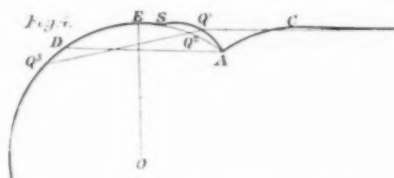
FIG. 4.   STUD CENTER PATH

from engagement. The result here proved the case, the path being a straight line ending with an arc before engagement with the wheel. The measurement of this arc, i.e., 80 per cent of the pitch of the chain, should be noted—the probable explanation lies in the fact that the rear stud continued to drop until the forward stud reached the point of action.

IMPACT TESTS

Nos. 4, 5, 6, 7 and 8 may be termed impact tests, and would have been more complete if they had been duplicated with the pointer on the rear stud of the outside link, and if the horsepower could have been accurately measured.

All these tests were severe—a $10T$ driver wheel and chain speeds varying from 560 ft. per minute to 1,500 ft. per minute.

Tests 4, 5 and 7 had no appreciable load, and speeds alone were varied. The effect of impact was clearly marked on the stud path, the stud being actually "thrown" by impact off the pitch circle path. In No. 4 test it was thrown for 20 per cent of the pitch arc; in No. 5 test for 30 per cent of the pitch arc, and in No. 7 for 55 per cent of the pitch arc. No. 8 test gave the same result as No. 5, which might be expected, since the only alteration was a slight increase in horsepower which could not be accurately measured. Test 6 was similar to test 7, the only difference being a considerable increase in horsepower transmitted. The length of the throw path was considerably less, having decreased to 33 per cent of pitch arc from 56 per cent.

In none of these tests were there any signs of arcs in the path leading to the wheel, but in every case the path dropped to the point of impact. If formula (*r*) is applied to tests 4 to 8, it will be found that the elasticity required is 0.0096 in. Before considering how this elasticity is provided it is advisable to state the two facts that have been established by these five tests.

1. Impact can throw a stud off its normal path.

2. To some extent the length of the throw varies with the speed and inversely with the pull of the chain.

In tests 1, 2 and 3 it was found that lubrication provided 0.0022 in. of elasticity—possibly, from the fact

that tests 4 to 8 were run with 1½-in. pitch chain, whereas tests 1 to 3 were run with 1-in. pitch chain, it might be argued that more elasticity could be expected, but a detail investigation of the throw path proves that, if the stud can be thrown off its path, elasticity is not necessary to the extent provided for in formula (*r*).

LUBRICATION STUD PATH TESTS

In Fig. 4, let $AQ'S$ represent the throw path, A being the point of impact.

Now the length of the line $AQ'SD$ is greater than the length of the line AQ^2SD.

Hence the stud path speed is greater from the point A than is represented by speed (*b*).

But

$$\frac{Speed\ (b)}{Speed\ (c)} = \frac{\alpha}{\frac{180}{\pi}} \sin \alpha$$

which is constant for any given wheel.

Hence if speed (*b*) is increased by impact, speed (*c*) is increased in the same proportion.

But the straight stud path is straight, hence the straight speed must be greater than that supplied by speed (*c*). In other words, the effect of the throw path is equivalent to increasing the pitch circle diameter, which, in turn, increases the straight speed and so reduces the difference between speed (*b*) and speed (*c*).

It is thus obvious that if sufficient elasticity cannot be supplied by the chain and wheel either a throw path must exist, or else the chain in the straight will "pitch arc."

It must be noted from these tests, 4 to 8, that the length of the throw path varies, that, in fact, it increases with the speed of the chain and decreases with the load. It must also be noted from Fig. 4 that when the center of the stud is on the throw path it is not in gear with the wheel and does not come into gear with the wheel until it reaches the point S, hence action commences at S.

This explanation accounts for the reduction of length of throw path in test 6, as compared with test 7. No. 7 test was taken with the chain running with practically no load so that it was only necessary for the wheel to impart a short push during the period of reaction and before the second period of inaction commenced.

In test 7 the second period of inaction commences at a point which corresponds to 79 per cent of the pitch arc, whereas owing to the light load the period of action only commenced at a point corresponding to 56 per cent of the pitch arc. In test 6 the load was increased and the period of action started at a point equivalent to 33 per cent of the pitch arc.

When the speed is high and the number of teeth in a wheel is so low that a throw path exists, the effect on the chain is what may be described as vibratory whipping, this whipping being caused by a series of jerks from the teeth of the wheel. Whipping may exist owing to an impulsive load, but these two types of whipping can usually be distinguished by their frequency and depth—the impulsive load type being less frequent and of greater depth.

ARCHED LINK TESTS

Tests 9, 10 and 11 were carried out with the arched link type of chain (commercially known as noiseless or silent type). The characteristics of these paths is in the easy curve at the point of impact—thereby showing that impact is absorbed gradually. A brief look at the

design will show that the arch link when subjected to a sudden load can supply elasticity by elongation and that the effect of this elongation is to produce gearing at that part of face of link furthest from the stud center. This means more gradual engagement and explains the reason for this design being, under normal conditions, quieter than the roller design. Lubrication also supplies elasticity as in the roller tests.

Test 12 was carried out with a load which gave a very low factor of safety—the stud path is most instructive—without resorting to the wax board it was easy to see the light waves throughout the length of chain between driver and driven wheel. It will be noticed that this wave is similar to that obtained in No. 1 test (i.e., when lubrication was absent), but in No. 12 test oil was being pumped into the chain; however, the bearing pressure on the studs was so great that oil could not reach the surface.

These few tests are given to show that the practical results obtained agree with the theory, and that having established a portion of the theory the complete theory can be developed together with the practical stud path tests. For the value of the stud path test is one which no firm of chain makers can afford to overlook.

CHAIN CURVE

Before closing the subject it is necessary to place on record a few notes connected with the chain leaving the driver wheel, entering the driven wheel, and leaving the driven wheel.

When a chain is running at a fairly high speed with wheels having a small number of teeth, it will be observed that it takes an inward curve after leaving the

Fig. 5.

Driver

Driven
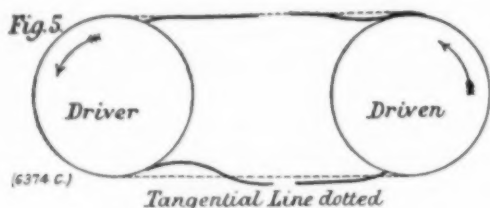
(6374 C.)

Tangential Line dotted

FIG. 5. CHAIN CURVE

wheel as shown in Fig. 5. This can be seen in both cases, i.e., leaving the driver wheel or leaving the driven, and is accounted for by the fact that the speed (*b*) is greater than the straight speed (*c*). In consequence, since the chain cannot alter from one speed to another instantaneously, it is necessary for it to assume a curve whose function is deceleration.

The same theory can be applied to the chain entering the driven wheel as has already been applied to it entering the driver wheel. The speed has to increase from speed (*c*) to speed (*b*)—*Tn* being of course inserted in obtaining the value of α. This speeding up occurs by impact supplied from the driven wheel, and since there is no load being transmitted and the chain is slack the throw path will be found to be so serious as to prevent a very slack chain being run at a high speed with a small driven wheel, since the chain will then get thrown out of gear with the wheel.

American Export of Dyes and Dyestuffs

The total amount of dyes and dyestuffs exported from the United States during the calendar year 1919 amounted in value to $17,084,435, of which Japan imported $3,196,550 and Canada $2,143,097.

German-French Potash Negotiations

"The result of the war has broken the former German world monopoly of potash, since by the terms of the peace treaty the thirteen Alsatian works have passed into the control of the French State," says the *Frankfurter Zeitung* for June 30. Although the output of Alsace, as compared with that of Germany, is relatively small, it is nevertheless important enough to affect prices on the world market. During 1919 Alsace produced 40,000 metric tons of potash, while it is expected that the output for 1920 will be five times that amount. The total sales of the German potash syndicate during 1919, in which 198 works participated, amounted to 812,000 metric tons of K_2O, and the output is capable of great development. Concerning this newly arisen competition the *Zeitung* says:

> Neither in France nor in Germany has the state or the producing industry any interest in spoiling prices on the world market by competition. In view of present economic conditions it is to the benefit of both countries to develop their export at the best possible prices. An agreement between France and Germany as to potash prices on the world markets would therefore be to the advantage of both. At a recent general meeting of the Deutschen Kaliwerke a. G. it was reported that negotiations were then going on with France with the object of coming to an agreement regarding the Alsatian potash industry. The result of the negotiations cannot yet be foreseen; however, the economic interests common to both countries should be strong enough to overcome present objections and difficulties. It must not be forgotten that sooner or later Spanish potash will appear on the world markets. Also that overseas sales are not being made easier by the substitute industries which are being founded, as an example in the United States.
>
> The chairman of the Deutschen Kaliwerke a. G. reported that sales are still slack. On political grounds, and in consequence of the unfavorable state of their currencies, sales to Poland and Czechoslovakia have almost entirely ceased. This is the more regrettable as sales to Poland in normal times are estimated at about 1,000,000 double centners (about 110,000 short tons) of pure potash.

Shark Fishing in Lower California

The shark-fishing industry is becoming increasingly important in the Ensenada consular district. The Lower California shark, known locally as the dogfish shark, is from 4 to 5 ft. long and weighs from 90 to 125 lb. The fishing is usually done by individual fishermen working out from camps on land. The fish are caught on long set lines, on which are fifty to one hundred hooks baited with small fish or lumps of shark meat. These lines are secured to floats, and the fisherman visits the lines daily to remove the catch.

The fins are sold for consumption by Chinese in shark-fin soup. The liver is boiled down and shark oil rendered out; each liver gives an average of 1 gal. of oil. This oil is used in paints and as a leather preservative. The remainder of the fish is dried and made into fertilizer or chicken feed. The skins are not utilized, except for fertilizer. Frequently shark steaks are sold by Chinese under the name of grayfish.

The large canneries operating fish-fertilizer plants in San Diego, Cal., are eager to buy shark, and the newly finished plant at Sauzal, Lower California, expects to specialize on converting shark into fish-meal fertilizer. Whereas formerly sharks caught in nets were separated from the more valuable fish and returned to the water, they are now brought ashore, although the demand is not yet sufficient to warrant using nets for sharks exclusively.

Studies of the Macrostructure of Cast Steel

Simple and Reliable Procedure Is Outlined for the Development and Record of Macrostructure—A Peculiar Banded Structure Is Described—Symmentrical Arrangement of Dendrites Is Necessary for Consistent Physical Tests—Pouring Cold Metal Suppresses Dendrites

By FRED G. ALLISON AND MARTIN M. ROCK*

WE HAVE wondered for a long time why it is that a larger number of the host of investigators in the field of metallurgy have not given more attention to the many easily observed but as yet unexplained phenomena which occur in the steel foundry. This may be due in part to the fact that experimenting with molten steel is too large a task for the laboratories of the average educational institution and in part to the fact that the attention of the foundry metallurgist is very largely absorbed with problems of immediate production. Whatever the cause may be, it seems that the steel foundry offers exceptional opportunities and a fertile field to the research metallurgist.

In his paper on "The Elastic Development of Steel," published in CHEMICAL & METALLURGICAL ENGINEERING of April 14, 1920, Sidney Cornell expresses the view that it would be a step toward betterment in the art of heat treating steel if more experimenters would simply publish observed facts without waiting for the development of completed treatises. We are in hearty accord with this view not only as it applies to the heat treating of steel but also in its application to the subject matter of this paper. Our observations on the macrostructure of cast steel are decidedly incomplete and the conclusions only tentative, yet they have seemed sufficiently interesting to justify this presentation.

RECENT PUBLICATIONS BY HUMFREY, LE CHATELIER AND BOGITCH

Interest in the macrostructure of cast steel was first aroused through the study of its microstructure and especially by the fact that the picric acid structure is apparently only slightly changed by what is known as a straight anneal. This interest was, however, greatly stimulated by two recent papers in the technical journals. One of these is by J. C. W. Humfrey[1] in the *Iron and Steel Institute* (1919) and the other by H. Le Chatelier and B. Bogitch[2] in *Revue Metallurgie*, vol. 16, No. 2, March-April, 1919.

Le Chatelier and Bogitch note the strange difference between the transitory and easily modified structural appearances caused by carbon and observed at relatively high magnification, and the entirely independent structural features observable by the naked eye—features which are extremely stable and almost unstudied, despite their industrial use in identifying steels of quality. They melted electrolytic iron in a closed silica tube under 3 or 4 cm. pressure of hydrogen, with or without additions of phosphide. Stead's reagent, Heyn's reagent, an iodine reagent (iodine 10 g., KI 20 g., H_2O 100 c.c.)

and boiling acid did nothing to such samples except tone the allotriomorphic ferrite crystals differently. On the other hand, if electrolytic iron, with or without additions of chemically pure iron sulphide, iron phosphide, iron oxide, manganese or silicon, be melted in a gas furnace, any of these reagents will reveal marked chemical homogeneity unrelated to the ferrite crystals. Stead's reagent as modified by Le Chatelier and Dupuy (95 per cent ethyl alcohol 100 c.c., water 10 c.c., cupric chloride 1 g., picric acid ½ g. and hydrochloric acid 1 to 3 c.c.) gives exactly reverse action to the other reagents, as comparative studies on the same section prove.

That such differential etching is due to oxygen only is proved by the method of melting, by the fact that
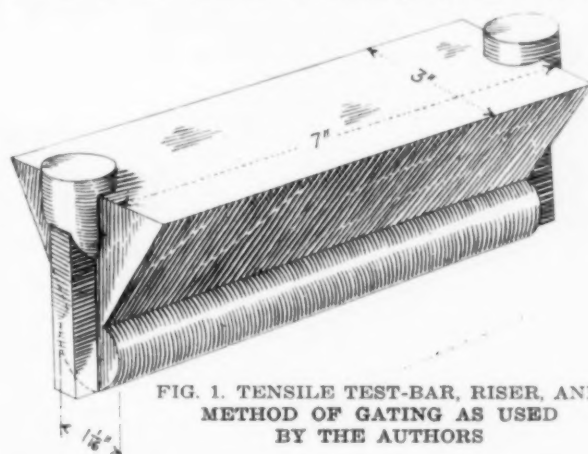
FIG. 1. TENSILE TEST-BAR, RISER, AND METHOD OF GATING AS USED BY THE AUTHORS

an annealing in hydrogen produces a superficial immunity. Comparing the action of Stead's reagent on steels with constantly increasing oxygen content, the authors advance their conclusion that this reagent attacks parts poor in oxygen, while the others eat into parts rich in oxygen.

The black marks made on bromide paper moistened with 2 per cent H_2SO_4 when in contact with steel are said to be due to sulphur only, since no markings occurred when testing any of the sulphur-free melts. Again, fumes from dissolving cast-iron filings will blacken such paper, yet if they are first bubbled through lead acetate they are without effect, and the lead precipitate upon analysis will be found to contain sulphur.

In his paper on "Macro-etching and Macro-printing" Humfrey recommends polishing the specimens with emery cloth, etching deeply with a 12 per cent aqueous solution of cupric ammonium chloride, to eliminate tool marks and surface hardening.

Etching is continued by the reagent cupric ammonium chloride 120 g., concentrated hydrocloric acid 50 c.c. (more or less), water 1,000 c.c., by pouring on fresh additions at intervals. Deposited copper can readily be
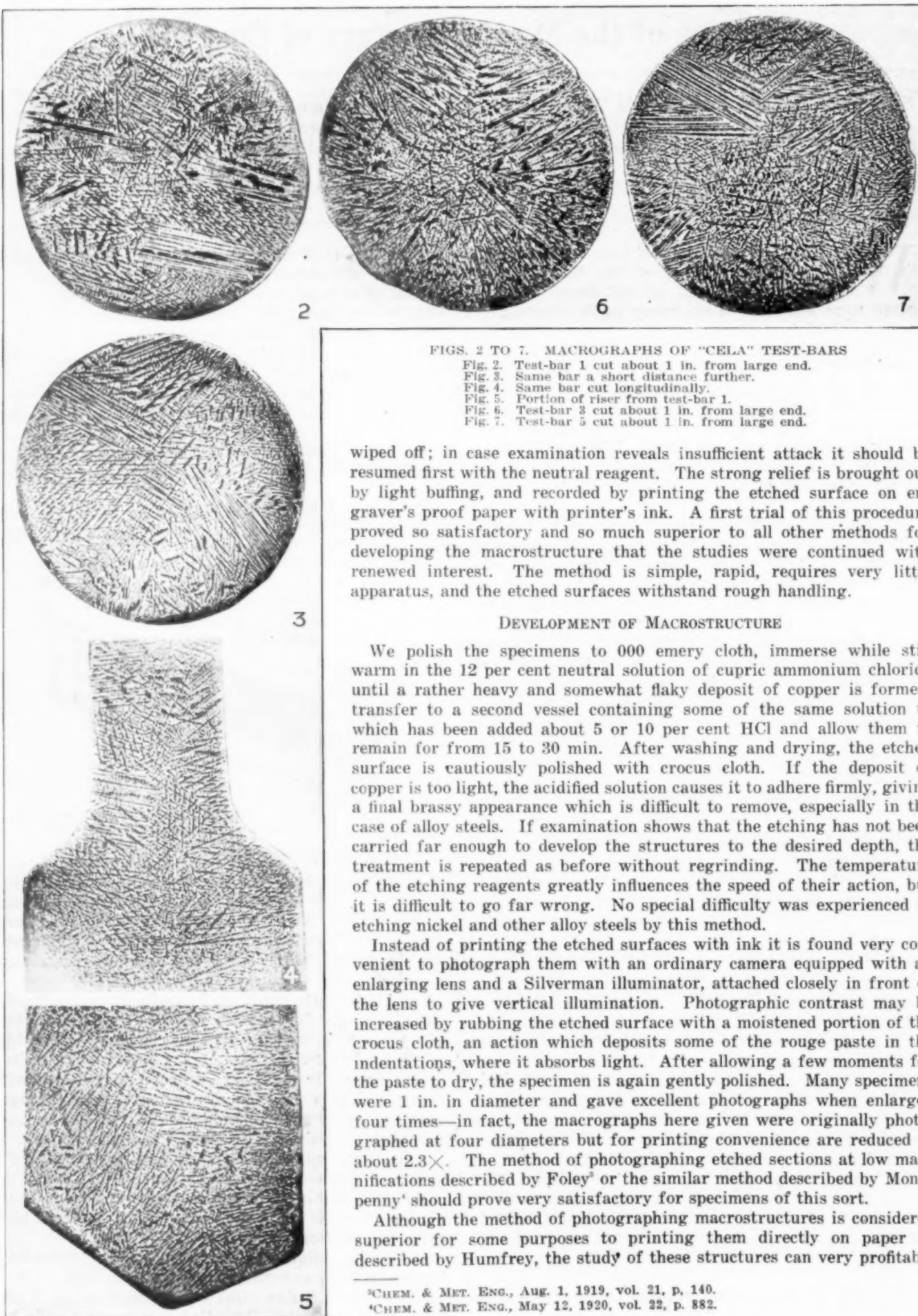
FIGS. 2 TO 7.   MACROGRAPHS OF "CELA" TEST-BARS
Fig. 2. Test-bar 1 cut about 1 in. from large end.
Fig. 3. Same bar a short distance further.
Fig. 4. Same bar cut longitudinally.
Fig. 5. Portion of riser from test-bar 1.
Fig. 6. Test-bar 3 cut about 1 in. from large end.
Fig. 7. Test-bar 5 cut about 1 in. from large end.

wiped off; in case examination reveals insufficient attack it should be resumed first with the neutral reagent. The strong relief is brought out by light buffing, and recorded by printing the etched surface on engraver's proof paper with printer's ink. A first trial of this procedure proved so satisfactory and so much superior to all other methods for developing the macrostructure that the studies were continued with renewed interest. The method is simple, rapid, requires very little apparatus, and the etched surfaces withstand rough handling.

DEVELOPMENT OF MACROSTRUCTURE

We polish the specimens to 000 emery cloth, immerse while still warm in the 12 per cent neutral solution of cupric ammonium chloride until a rather heavy and somewhat flaky deposit of copper is formed, transfer to a second vessel containing some of the same solution to which has been added about 5 or 10 per cent HCl and allow them to remain for from 15 to 30 min. After washing and drying, the etched surface is cautiously polished with crocus cloth. If the deposit of copper is too light, the acidified solution causes it to adhere firmly, giving a final brassy appearance which is difficult to remove, especially in the case of alloy steels. If examination shows that the etching has not been carried far enough to develop the structures to the desired depth, the treatment is repeated as before without regrinding. The temperature of the etching reagents greatly influences the speed of their action, but it is difficult to go far wrong. No special difficulty was experienced in etching nickel and other alloy steels by this method.

Instead of printing the etched surfaces with ink it is found very convenient to photograph them with an ordinary camera equipped with an enlarging lens and a Silverman illuminator, attached closely in front of the lens to give vertical illumination. Photographic contrast may be increased by rubbing the etched surface with a moistened portion of the crocus cloth, an action which deposits some of the rouge paste in the indentations, where it absorbs light. After allowing a few moments for the paste to dry, the specimen is again gently polished. Many specimens were 1 in. in diameter and gave excellent photographs when enlarged four times—in fact, the macrographs here given were originally photographed at four diameters but for printing convenience are reduced to about $2.3\times$. The method of photographing etched sections at low magnifications described by Foley[3] or the similar method described by Monypenny[4] should prove very satisfactory for specimens of this sort.

Although the method of photographing macrostructures is considered superior for some purposes to printing them directly on paper as described by Humfrey, the study of these structures can very profitably

[3]CHEM. & MET. ENG., Aug. 1, 1919, vol. 21, p. 140.
[4]CHEM. & MET. ENG., May 12, 1920, vol. 22, p. 882.

be undertaken without printing of any sort. Examination of the etched sections with a simple hand lens, such as is commonly used for the examination of fractures, is in many respects the most satisfactory method. The entire process is so simple that, as Le Chatelier and Bogitch state in the article referred to above, it seems surprising that the structures revealed have not been studied more in the past. Etching by this method might very well be included among the first laboratory exercises accompanying a systematic study of metallography.

WHAT DOES DEEP ETCHING REVEAL?

Deep etching of steel has been employed by investigators for many years, but the exact nature of the structures developed seems still to be in some doubt. Stead's and other similar reagents, which are said to show phosphorus segregation, give effects which are practically identical with those produced by Humfrey's and similar procedures. The so-called sulphur print also shows about the same structures. According to Humfrey the etching reagents dissolve most those portions of the metal which solidified first. From the results of their very carefully conducted experiments Le Chatelier and Bogitch, on the other hand, draw the conclusion that the heterogeneity is caused by oxygen in some state of combination—viz., FeO, $FePO_4$, etc.

A large number of the specimens which we have examined were obtained from the standard tensile test-bar and its riser which the George H. Smith Casting Co. is using at the present time. A sketch of this test-bar with riser and method of gating is shown in Fig. 1. The mold is made in two parts in a core box and is cemented and baked in the usual way. For the tensile test the cylindrical portion is cut off with a power hacksaw and machined to standard size, leaving the ends about ⅜ in. in diameter. This pattern gives a solid test-piece which can be machined to size with a minimum of effort.

BANDED AND LATTICE-LIKE STRUCTURE

Among the first specimens which we etched with Humfrey's procedure were three broken tensile test-bar stubs from a small experiment which we conducted

TABLE I.   PHYSICAL PROPERTIES OF "CELA" TEST-BARS

Test-Bar No.	Additions of "Cela," per Cent	Yield Point, Lb. per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In., per Cent	Reduction of Area, per Cent
1	None	43,500	73,500	29.5	50.1
2	None	42,740	74,300	30.5	48.6
3	0.10	45,500	74,250	30.0	33.4
4	0.10	44,140	74,350	32.0	50.0
5	0.15	45,750	74,000	30.0	48.1
6	0.15	44,090	74,700	29.5	42.5

with "cela" (cerium-lanthanum alloy) as a deoxidizing agent for converter steel. Six test-bars of the type shown in Fig. 1 were cast from a small ladle of a heat analyzing as follows: Carbon 0.22, silicon 0.45, sulphur 0.070, phosphorus 0.063, manganese 0.69 per cent. To two of these bars no "cela" was added; to the second pair enough was added to make about 0.10 per cent,
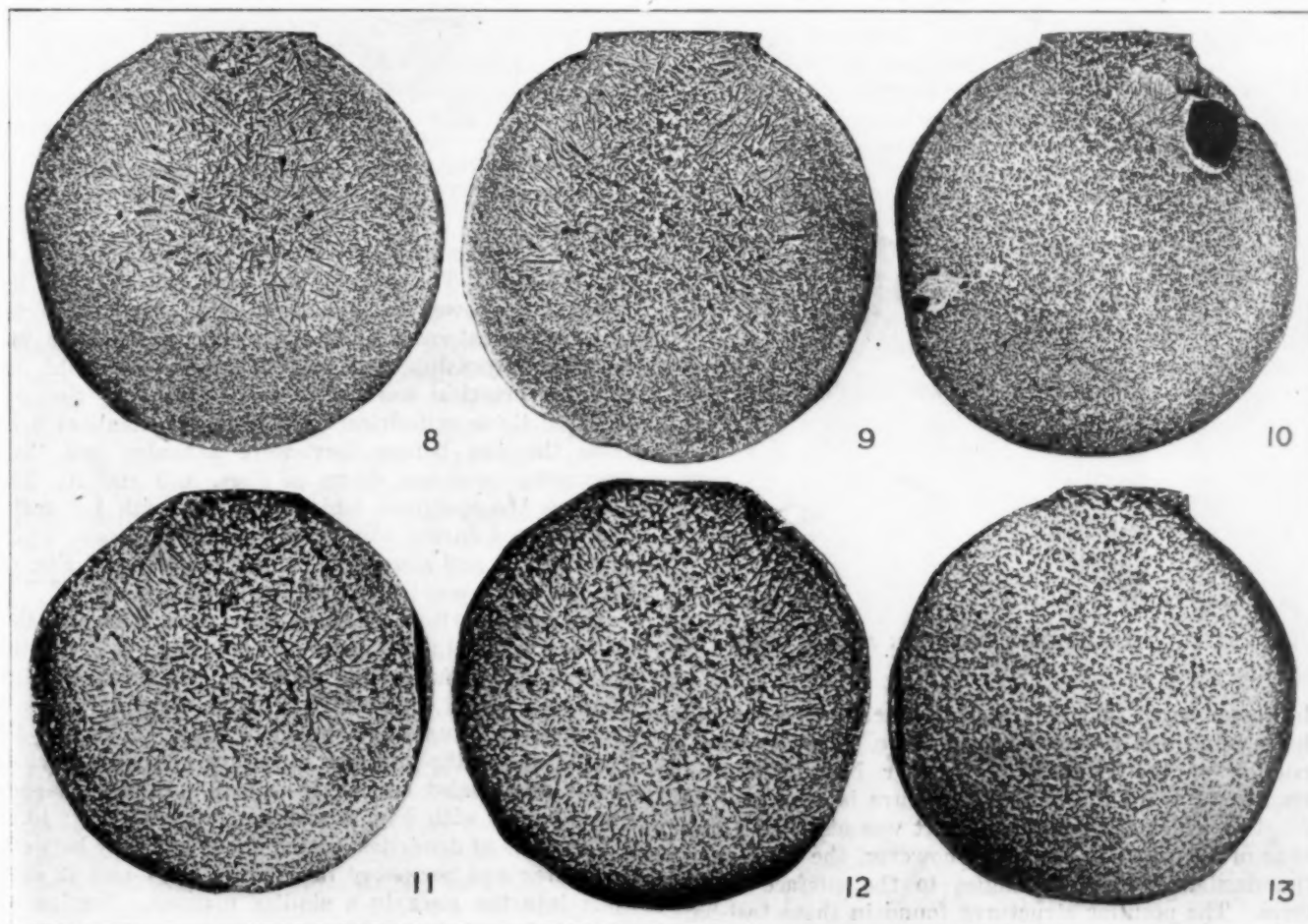
FIGS. 8 TO 13

Fig. 8. Hot-poured steel, mold jarred during solidification.   Fig. 9. Hot-poured steel, quietly cooled.   Fig. 10. Cold-poured steel.
Fig. 11. Same as Fig. 8 after annealing 5 hr. at 1,832 deg. F.   Fig. 12. Same as Fig. 9 after annealing 5 hr. at 1,832 deg. F.   Fig. 13. Same as Fig. 10 after annealing 5 hr. at 1,832 deg. F.

and to the third pair enough to make about 0.15 per cent. Although no special observation was made at the time, it is thought that the molten metal was very hot. These test-bars were all heated for four hours at 1,650 deg. F. (900 deg. C.) and cooled slowly in the furnace. The tensile tests, made by two different firms of inspecting engineers, are given in Table I. Although these data are not given especially for that purpose they show that the "cela" conferred no evident benefit.

The broken stubs from test-bars No. 1, 3 and 5 were cut about 1 in. from the large end and the structures developed are shown in Figs. 2, 6 and 7 respectively. The photographs show the entire end of the bars, the indentations at the circumference being caused by the jaws of the tensile machine.

The banded dendrites and lattice-work structures seen in Figs. 2 and 7 are interesting, to say the least. At first glance they suggest massive slip lines, perhaps due to the combined forces in the tensile machine, but no evidence supports such a suggestion. Fig. 6 (a section of bar No. 3) shows only the expected radial arrangement of the dendrites. This bar, however, showed the lowest reduction of area of any in the lot and it is possible that there is some connection between these facts.

Fig. 3 shows a second section through bar No. 1, a short distance from that shown in Fig. 2, and Fig. 4 is a longitudinal section through part of the same piece. The banded dendrites and lattice-work structure evidently extended throughout this cylindrical part and in all planes. In examining Figs. 2, 3, 6 and 7 it should
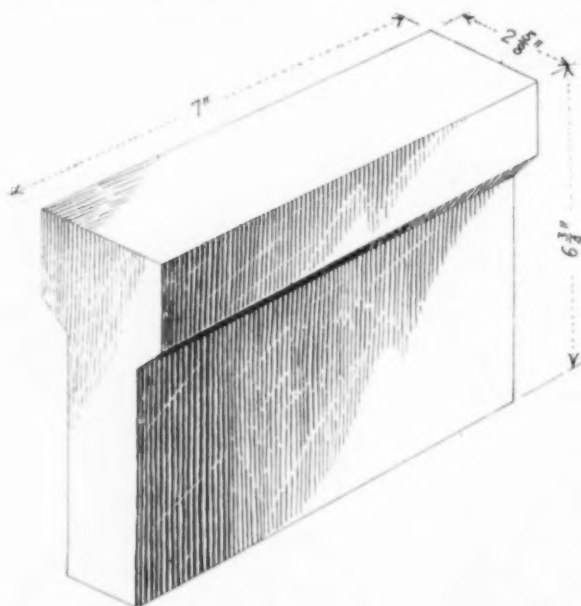
FIG. 14. TEST COUPON POPULAR AMONG STEEL FOUNDERS

be remembered that only a small amount of metal, perhaps ½ in., was removed by the lathe. Fig. 5 shows a portion of the riser from test-bar No. 1. Here a tendency toward the banded structure is seen near the point at which the cylindrical part was attached (lower edge of figure). In the main, however, the riser shows the dendrites at right angles to the surface of the mold. The peculiar structures found in these test-bars may have been caused by deformation of the normal radial dendrites during the mushy stage. The tensile tests show that their quality was unimpaired. It may be worth noting in this connection that hot cracks in

steel castings sometimes show banded dendrites similar to those of Fig. 2. Their appearance has been usually attributed to exudation of the semi-fluid metal.

MACROSTRUCTURE OF COLD-POURED METAL

Writing of the elements of fiber, Howe[*] states that "The conditions which favor the dendritic form are rapid and quiet solidification." It is well recognized by steel foundrymen that it is difficult to refine the structure of a casting which has coarse dendrites and that the simplest way to avoid this difficulty is to pour the metal at the lowest practicable temperature. These thoughts prompted us to make the following experiment.

Three test-bars of the type shown in Fig. 1 were cast from a small ladle of a heat of converter steel which analyzed as follows: Carbon 0.37 per cent, silicon 0.42 per cent, sulphur, 0.063 per cent, phosphorus 0.056 per cent, manganese 0.72 per cent. The first of these three test-pieces was poured with the metal very hot (no pyrometer was used) and the board beneath the mold

FIG. 15. CROSS-SECTION OF TENSION TEST-PIECE MADE FROM COUPON SHOWN IN FIG. 14

was pounded continuously during solidification with an air rammer. The second was also poured with hot metal, but allowed to solidify quietly. Pouring of the third was postponed until the metal in the ladle was as cold as possible and still flow into the mold, too cold for practical work with small castings. Sections of these three cylindrical bars were cut at about ¾ in. from the end before they were annealed and their macrostructures are shown in Figs. 8, 9 and 10. Fig. 8 shows the specimen which was cast with hot metal and vibrated during solidification, Fig. 9 the one which was cast hot and allowed to solidify quietly and Fig. 10 the one which was poured with very cold metal.

The main portions of these bars were then annealed by heating to 1,832 deg. F. (1,000 deg. C.), holding for five hours and cooling slowly in the furnace. Sections were again cut about ¼ in. from the previous ones and their structures are shown in Figs. 11, 12 and 13. Fig. 11 shows the annealed structure of a section close to the unannealed section in Fig. 8. In like manner Fig. 12 goes with Fig. 9 and Fig. 13 with Fig. 10.

The zones of dendrites located about half way between the center and periphery in Figs. 8, 9, 11 and 12 continue into the riser in a similar manner. Jarring of the metal during solidification seemed to produce no effect, although the small size of the casting and probable rapid solidification may be responsible. Although the

*"The Metallography of Steel and Cast Iron," p. 553.
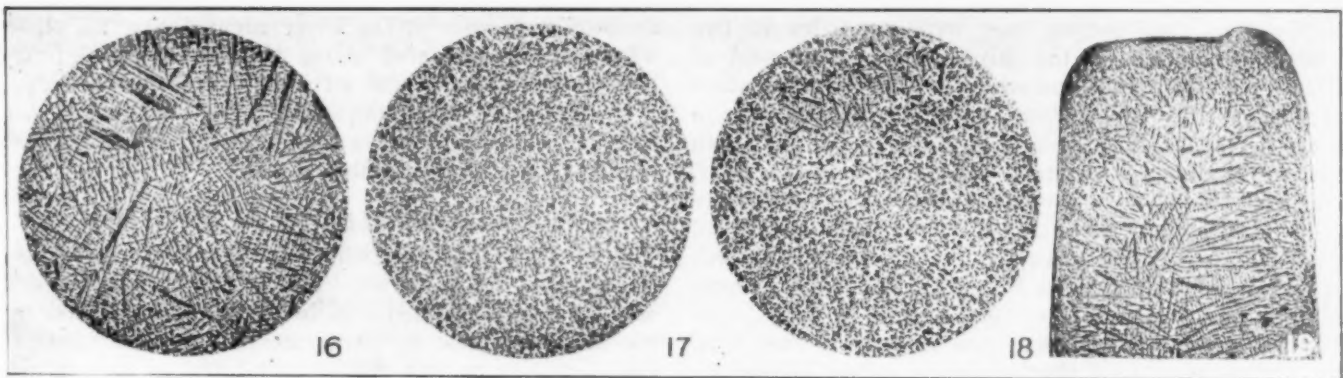
FIGS. 16 TO 19

Fig. 16. Typical macrostructure of hot-poured steel.   Fig. 17. Typical macrostructure of cold-poured steel.   Fig. 18. Isolated accumulation of dendrites.   Fig. 19. Section of small steel casting.

annealing treatment was much more vigorous than would ordinarily be used in a steel foundry, diffusion was quite imperfect. The smaller branches of the dendrites disappeared, and the grain size, if it may be so called, in the non-dendritic areas seems to have enlarged somewhat. Although the photographs do not show it very well, the grain or crystal boundary lines in the annealed specimens are indefinite and show that diffusion was in progress. The comparative effect of hot and cold pouring is shown very clearly. The gas cavities shown in Fig. 10 are such as usually occur when steel is cast at too low a temperature. Close to these gas cavities there are small areas which seem to consist of very small dendrites. Just what causes them might develop into an interesting question. The test-bar corresponding to Fig. 12 gave the following tensile test: Yield point 48,500 lb., tensile strength 84,750 lb., elongation in 2 in. 22.5 per cent, reduction of area 30.8 per cent.

Strength as Affected by Shape of Coupon

A number of tests were conducted with different heats to find out if the casting temperature would affect the tensile strength. The standard test coupon, shown in Fig. 1, was used, but the results thus far are inconclusive. It seems probable that our failure to find the expected difference in every case may be due in large part to the shape of the bar as cast. With this cylindrical shape, cast hot, there is frequently an area in the center with a network or "delta" structure, and that is really the portion which is tested. Moreover, with a normal radial arrangement of dendrites reaching uniformly to the center, the machined test-bar would have a "balanced" strength on all sides. Previous experience with many different types of tensile test coupons has indicated that this matter of "balanced strength" is very important.

Fig. 14 shows a type of test-piece or coupon which has been used extensively by steel foundries. Several slices suitable for machining into tensile-test bars may be cut from each piece. Fig. 15 shows the macrostructure of a cross-section of a tensile-test stub made from the first cut of such a coupon, cast with hot metal. An examination of this figure shows very clearly the side at which it was attached to the main portion. Test-bars which show this arrangement of dendrites, when placed under tension, frequently develop incipient cracks along one side before breaking. Such test-bar stubs may be etched with copper reagents without further polishing and there seems to be a definite relation between the incipient cracks and a coarse macrostruc-

ture. As a rule, the second cut from this style of test coupon gives a poorer tensile test than the first cut.

In the study of the effect of casting temperature, many sections of the cylindrical bars and V-shaped risers, cast with hot and cold metal analyzing about 0.25 per cent carbon and 0.70 per cent manganese were examined. Although exact temperature readings were not taken and the structures varied somewhat, Figs. 16 and 17 show typical hot and cold structures of 0.25 per cent carbon steel. These figures were derived from the risers and are from the same heat. Fig. 18 shows a small dendritic area entirely surrounded by non-dendritic. This particular area was located near the top of a riser. Fig. 19 is a section through the end of a small casting. Both of these figures show again that the growth of dendrites does not always start at the surface of the mold.

A study of sections of variously shaped castings shows that if the flowing metal passes through a long channel it is sufficiently cooled by contact with the mold surface to greatly reduce the likelihood of a dendritic structure.
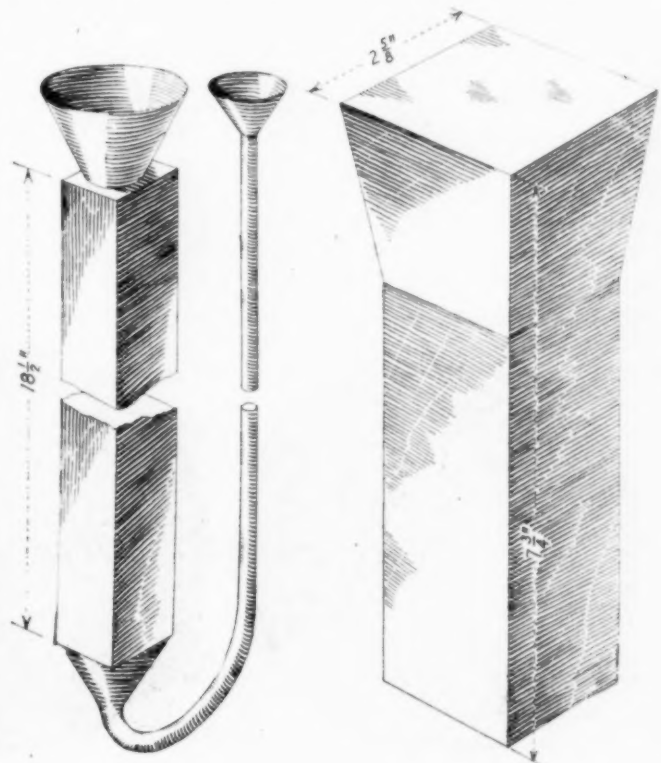
FIG. 20.
Long bar cast vertically, with gate, runner and riser.

FIG. 21.
Ingots for chemical analysis.

A T-shaped cross-section may have dendrites in two branches, but none in the third. If the movement or flow of molten metal continues until the temperature approaches the mushy stage, nuclei for crystal growth seem to appear throughout the entire mass, and both space and time for dendritic growth are lacking. If, however, this flow is continued until the temperature drops still further, there seems to be a tendency toward what may be called a variety of segregation. This condition is illustrated in Fig. 22. This figure represents a cross-section near the top of a long small casting poured with rather cold metal. A sketch of the pattern with method of gating is shown in Fig. 20. In pouring this casting the first metal to enter passed down 18 in. through the runner, then up 18 in. to the top. The small dark rounded areas of Fig. 22 are gas cavities similar in nature and cause to those seen in Fig. 10. The concentric arrangement of those constituents which are least attacked by the reagents seems to have been due to the flow continuing into the early part of the mushy stage.

The effect of movement of the molten metal as its temperature approaches the solidus upon the nature of the crystalline growth is well illustrated in Fig. 23. This figure is part of a section of a feeder about 2 in. in diameter. At the outside (top of figure) the normal radial dendrites are found; then there is an irregular zone of what, for a lack of a better name, may be called network structure; then a second zone of irregular dendrites, and in the center (bottom of figure) an area which seems to show segregation.

Figs. 24 and 25 are partial sections of chemical-test ingots which were cast in split iron molds. A sketch of one of these ingots is shown in Fig. 21. The walls of the small iron molds in which these are cast are about ⅜ in. thick, and the metal solidifies very quickly. The ingot from which Fig. 24 was derived was cast with hot metal (carbon 0.20 per cent). The very small, needle-like dendrites should be compared with those in Fig. 16, which shows hot poured steel of similar composition but cast in a dry sand mold. The ingot represented by Fig. 25 was cast with 0.36 per cent carbon steel, temperature of casting unknown. The small grain size here should be compared with that seen in Fig. 17. The carbon content was different, and that may be partly responsible for the great difference in size of grains. The light areas at the bottom of both Figs. 24 and 25 were in the centers of the ingots. These areas, like the one at the lower edge of Fig. 23, show what may be considered segregation, although the practical foundryman would attribute them to shrinkage. It is difficult to understand how there could have been sufficient time for segregation strictly as understood to take place in the chilled ingots.

MANY UNKNOWN CAUSES OF STRUCTURE

Many of the factors which influence the formation of dendrites are unknown. Two of the most important may be mentioned here as being well established by the data and also as being in line with theoretical considerations on this matter. The first is the relative
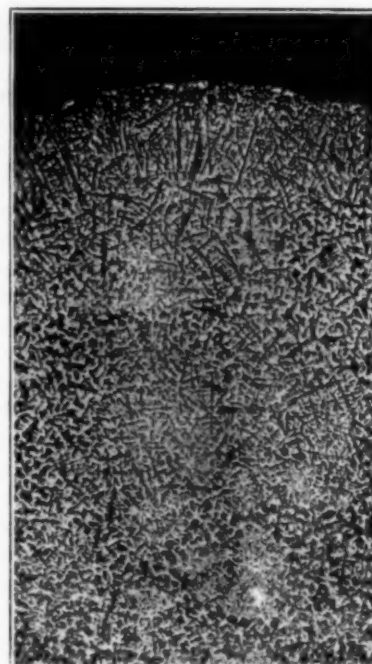
Fig. 23. Variable macrostructure in 2-in. feeder.

temperature of different parts of the molten mass during the solidification period, or, in other words, the thermal gradient. Dendrites grow from nuclei formed at or below the solidification point toward the hotter regions, as from the surface toward the center. Local heating or cooling conditions, such as the flow of metal through certain parts of the ingot, or the presence of a cavity, may cause a change in the direction of the

22

24

25
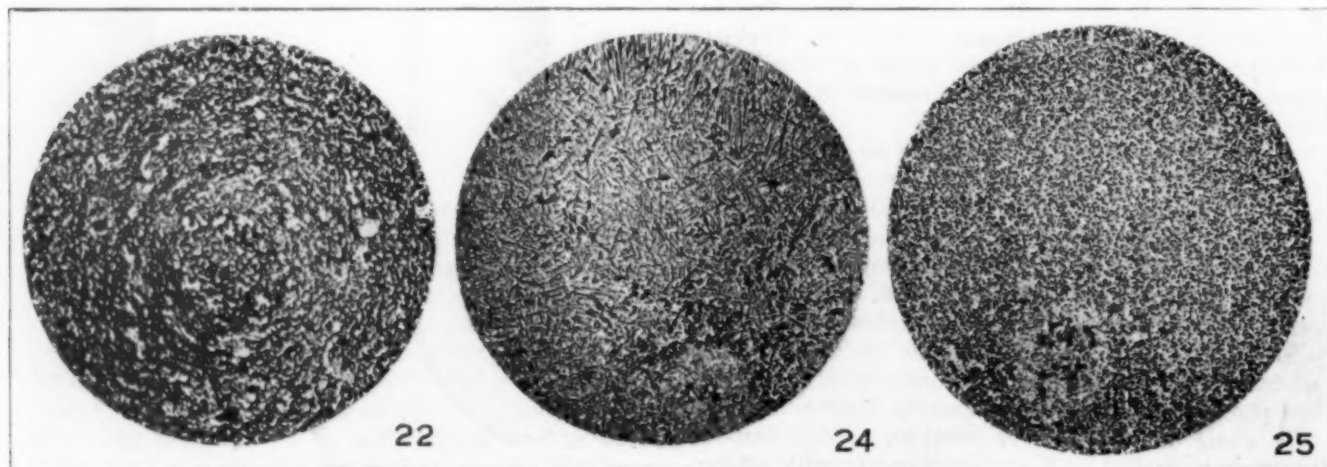
Fig. 22. Segregation in end of long casting.

Fig. 24. Hot steel cast in iron mold.

Fig. 25. Cold steel cast in iron mold.

dendrites. Again, if the metal when poured is near the solidification point, the conditions for dendritic growth may be lacking and the metal will solidify around nuclei well distributed throughout the mass, giving rise to the network structure. Second, selective freezing no doubt has a very important effect upon the macrostructure. This would account for the influence of phosphorus or of oxygen, if the theory of Le Chatelier and Bogitch be correct. But other elements besides these two have an influence upon selective freezing.

Our firm makes a very low-carbon cast steel which is used extensively for dynamo and motor frames because of its high magnetic permeability. This steel runs about 0.07 per cent carbon, 0.06 per cent silicon and 0.05 per cent manganese. Although cast at a very high temperature, an examination of a number of specimens shows that dendrites are of rare occurrence. The phosphorus content of this steel is as high as that of the higher carbon steel and there is every reason to believe that the oxygen content is at least as high. The absence of a well-developed macrostructure in this steel and its presence in the higher carbon steel cannot be accounted for by the theory that these two elements are the only controlling factors. Carbon, manganese and silicon may be considered to play an important part. So, too, alloy steels such as nickel and chromium show a highly dendritic structure.

CONCLUSION

In concluding this brief discussion of some miscellaneous studies of cast steel macrostructure, our previous statement may be repeated: The steel foundry offers exceptional opportunities and a fertile field to the research metallurgist. Most of the literature of the science of metallography, textbooks included, deals with forged or worked metal, and the technologist is still without accurate data on some very elementary matters. It is evident that a proper understanding of the crystalline structure of cast steel should begin with a study of its macrostructure.

Milwaukee. Wis.

Dyestuffs Trade in Japan

The following item appeared in the *Japan Chronicle* for June 4, 1920:

An official of the Mitsui Co. is quoted as stating that in Japan a small quantity of natural indigo was produced in Chugoku, Shikoku and Saitama Prefectures before the war, but the domestic demand for indigo was largely met by imports of the German indigotin. On the outbreak of the war the direct importation of German dyestuffs ceased, and prices rose in consequence, offering an opportunity for the establishment of dyestuff companies in Japan. The termination of hostilities, however, brought about a fall in price, and it is now considered that in view of the fact that Japanese dyes are inferior to foreign products in quality it is advisable to import the goods rather than to manufacture them at home. Even though Japan could produce dyestuffs equal in quality to those of foreign countries, it is unable to manufacture them at the same low cost.

Japan is able to manufacture black and methyl violet of good quality, and these manufactures not only supply the domestic demands but are exported to China in large quantities. Other kinds of dyes are, for the most part, imported from America, England, and Switzerland. The Miike factory of the Mitsui Co. is producing alizarine dyes.

The imports of dyestuffs into Japan for last year were valued at 15,000,000 yen ($7,477,500 at normal exchange), while in pre-war days the imports were about 5,000,000 yen ($2,492,500) worth of artificial indigo and about 5,000,000 yen ($2,492,500) worth of other kinds of dyestuffs. As the price was lower before the war, the quantity of imports was larger in pre-war years than last year. Before 1914, Germany and Switzerland were practically the only countries that produced artificial indigo, and most of the natural indigo was supplied by India and Java. The shortage during the war was very great, owing to the suspension of imports, and Japan was compelled to be economical with what it had left.

When the highest price was ruling, 200 yen ($99.70) per kin (1.32 lb.) was a common price. At present the market has fallen to 15 or 16 yen ($7.48-$7.98) per kin. This decline in price is partly due to the economic depression now prevailing. Up to the end of February last the market price of 24 to 25 yen ($11.96 to $12.46) per kin had been maintained. "Direct" black had been quoted at 8.40 yen ($4.19) per kin up to the end of February, but the price has fallen to 7 yen ($3.49). It is even said that in some cases it is sold as low as 5 yen ($2.49). At present there is no business and although a good price will have to be paid by the buyer, there is practically no price that can be demanded by the seller. In short, the price has fallen by 20 per cent, being influenced by the present economic depression. The official of the Japanese firm quoted believes that the market price of dyestuffs will rise in the future, however.

Decline in the Production of Graphite

A heavy decline in the production of graphite in the United States in 1919 is shown by preliminary estimates just made public by the United States Geological Survey.

The shipments of domestic graphite amounted to approximately 7,717 short tons, valued at $743,000, a decrease of about 41 per cent in quantity and 51 per cent in value from the figures for 1918. This decrease is apparently due to several well-known causes. After the War Industries Board, on Aug. 10, 1918, ordered the use of at least 25 per cent of American graphite in crucible mixtures to be sold during the year 1919, the purchases of domestic and Canadian graphite were heavy, reaching 500 tons or more a month during August, September and October, 1918. After the armistice was signed, however, on Nov. 11, 1918, an abrupt decline in shipments began, which was accelerated by the order of the War Trade Board of Jan. 16, 1919, removing all restrictions on purchases of graphite. This order naturally weakened the market, for customers were then already burdened by accumulated stocks. The cost of manual labor in the United States increased enormously in 1918 and 1919, but as the demand for graphite was weak and as the market was thrown open to foreign competition the producers were unable to raise their prices proportionately. Although marine freight rates had been increased, the producers of crystalline graphite in Ceylon and of flake graphite in Madagascar, by reason of cheap native labor and unusual conditions of foreign exchange, were able to market their product at prices that forced the smaller American producers to suspend production, so that at the close of the year 1919 only the strongest and best organized companies were able to continue operations.

DOMESTIC GRAPHITE SOLD IN 1915-1919
(Short Tons)

Year	Amorphous		Crystalline		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1915	1,181	$12,358	3,537	$417,273	4,718	$429,631
1916	2,622	20,723	5,466	914,748	8,088	935,471
1917	8,301	73,481	5,292	1,094,398	13,593	1,167,879
1918	6,560	69,455	6,431	1,454,799	12,991	1,524,254
1919	4,000	47,000	3,717	696,000	7,717	743,000

During 1919 the New York prices for the best grades of Ceylon lump graphite ranged from 13½ to 15½ cents a pound. Domestic flake brought from 4 to 10½ cents and dust from 1 to 3 cents.

Studies in Evaporator Design*—III

The Effect of Hydrostatic Head on Heat Transmission in Vertical Tube Evaporators — Method of Manipulation and Accuracy of Results — Maximum Heating One-Third Tube Depth†

By W. L. BADGER and P. W. SHEPARD

THIS paper reports a series of determinations of heat transmission in an experimental vertical tube evaporator, to show the effect of hydrostatic head (and incidentally the effect of the shape of the bottom of the evaporator) on this constant. This investigation was undertaken in the evaporator experiment station of the University of Michigan as a part of the general program of the study and correlation of all the factors and variables affecting heat transmission in evaporators. It was felt that since our general problem involved a quantitative study of evaporators on a larger scale, over wider ranges and with a different disposal of heating surface than any investigator has hitherto attempted as a research proposition, it would be well to risk the possible repetition of some of the work already done.

PRIOR LITERATURE

Claassen very early pointed out the fact that increasing the hydrostatic head on a surface must result in a decrease in heat transmission. He carried out some experiments[1] in a small experimental evaporator which has been described in a previous paper.[2] His experiments on this subject are only four in number and the actual hydrostatic head is not recorded. The experiments with "high" hydrostatic heads show a heat transmission about 5 per cent lower than those with "low" hydrostatic heads.

Hausbrand[3] omits entirely the discussion of this point with reference to heat transmission.

Kerr[4] has studied this point and has given several curves showing the effect of hydrostatic head on heat transmission. He shows that the maximum heat transmission occurs when the tubes are about one-third submerged, that the decrease in heat transmission at higher levels than this approximately follows a straight line and that this decrease is greater than the decrease calculated from the increased pressure. In other places in the literature[5] are found the statements that vertical tube evaporators give the maximum heat transmission when the tubes are about one-third submerged.

APPARATUS

The experiments here described were run in the vertical tube evaporator at the evaporator experiment station of the University of Michigan. This apparatus has been previously described[6]. The steam basket employed in these runs contains twenty-four 2-in. 13-gage

charcoal iron tubes, 30 in. long. These experiments are divided into three series corresponding to different arrangements of the evaporator. In series A the body of the evaporator from bottom flange to top flange was 8 ft. high and the evaporator was equipped with a round bottom. In series B an intermediate section was added so that the body of the evaporator was 12 ft. high, but otherwise the same as in series A. Series C was also run with the body 12 ft. high, but a 60 deg. cone bottom was substituted for the round bottom of the previous tests.

METHOD OF MANIPULATION AND ACCURACY OF RESULTS

These have been discussed in a previous paper and this discussion need not be repeated here.

Results. The results are given in Tables I, II and III and in Fig. 1. At levels above 24 in., all the results at a point were averaged. At levels below 24 in., the results when the round bottom was used are averaged separately from the results with the cone bottom. In all runs the liquor level averaged less than ½ in. from the desired point. Consequently all the individual results obtained at each level should be in a single vertical line. They are spread sideways a little to make it possible to distinguish individual determinations. There are several interesting features in this curve.

It will be noted that with the round bottom the maximum heat transmission occurs at exactly one-third submergence. This confirms the results of other investigators. It will also be noticed that at levels higher than the top tube sheet, heat transmission decreases with increase in level along a straight line; but this relation does not hold between the top tube sheet and the maximum.

The point of greatest significance is the difference in the shape of these curves, due to the shape of the bottom of the evaporator. The explanation for this difference is fairly obvious. As will be shown later, although these curves show the change in heat transmission as the liquor level is varied, this change is really due largely to changes in circulation and only to a small extent to changes in hydrostatic head. The round bottom contains a comparatively small amount of liquid in proportion to the amount above the bottom tube sheet and therefore circulation of the entire mass is very vigorous. The cone bottom contains a large mass of liquid which absorbs energy of circulation in eddy currents. With low liquor levels the proportion of liquid in the cone to liquid above the bottom tube sheet is large and therefore the effect of the cone is marked. As the liquor level rises the proportion of liquid in the cone becomes less, so that at levels approximately at the top tube sheet it has no effect on the general circulation.

The bearing of this relation on the design of evapo-

*Read before the American Institute of Chemical Engineers, June 27, 1920.
†For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 6 and 7, Aug. 11 and 18, 1920, pp. 237 and 281.
[1]*Z. Ver. Zuckerind.*, vol. 52, p. 373.
[2]See CHEM. & MET. ENG., vol. 23, No. 5, Aug. 11, 1920, p. 237.
[3]Verdampfen Kondensieren und Kuhlen, 6th Ed., 1918.
[4]Bull. 149, La. Agri. Exper. Sta.
[5]Webre, *J. Ind. Eng. Chem.*, vol. 10, p. 191; Rousseau, *Trans.*, A.I.M.E., vol. 38, p. 109.
[6]CHEM. & MET. ENG., vol. 23, No. 4, July 28, 1920, p. 159.

TABLE I. DATA OF INDIVIDUAL RUNS

Series	Run No.	Level, In. above bottom tube sheet	Time Min.	Absolute body pressure I_p mm.Hg	Corres. body temperature, t_w Deg. C.	Body temp. from thermometer Deg. C.	Absolute steam pressure mm.Hg	Corres. steam temp. t_g Deg. C.	Condensate temperature Deg. C.	Condensate lb.	Apparent temperature drop θ	Apparent K	U
A	50	3	50.33	285.4	74.69	73.88	769.1	100.33	93.47	309.0	25.64	873	178
A	47	6	36.42	286.2	74.74	73.46	762.0	100.07	96.14	695.0	25.33	2732	560
A	48	6	40.75	281.6	74.38	73.36	761.9	100.07	96.64	808.0	25.69	2796	573
A	49	6	37.80	283.5	74.54	72.46	767.2	100.26	96.57	716.0	25.72	2668	547
A	44	9	40.08	278.6	74.12	72.74	758.3	99.94	95.35	835.5	25.82	2925	599
A	45	9	35.75	280.1	74.26	73.28	764.6	100.17	96.73	708.0	25.91	2768	567
A	46	9	40.50	283.0	74.32	73.38	760.2	100.01	96.77	782.0	25.69	2722	558
A	40	12	39.75	270.4	73.42	72.84	761.5	100.06	94.80	776.0	26.64	2664	546
A	41	12	36.50	280.7	74.30	73.95	759.3	99.97	93.99	711.5	25.67	2763	566
A	42	12	38.75	280.4	74.27	72.95	762.3	100.08	95.91	764.0	25.81	2833	580
A	43	12	36.13	280.3	74.26	73.55	767.9	100.28	96.49	707.5	26.02	2724	558
A	36	18	48.25	282.0	74.40	74.07	764.8	100.18	94.47	807.5	25.78	2361	484
A	37	18	41.42	282.1	74.41	73.85	762.1	100.11	93.73	703.0	25.70	2405	493
A	38	18	47.42	286.1	74.89	74.07	759.4	99.98	94.35	790.0	25.09	2414	495
A	39	18	44.75	277.1	74.00	73.47	760.3	100.01	93.14	796.0	26.01	2494	511
A	32	24	51.50	283.4	74.53	74.60	761.1	100.04	93.30	789.0	25.51	2192	449
A	33	24	50.75	285.1	74.65	74.91	760.3	100.01	92.41	768.5	25.36	2179	446
A	34	24	49.83	285.7	74.70	75.00	760.5	100.02	93.73	737.5	25.32	2129	436
A	35	24	45.75	285.8	74.71	74.79	758.8	99.96	94.36	693.5	25.25	2179	446
C	2B	24	31.75	282.7	74.47	74.99	762.4	100.09	88.94	474.0	25.62	2141	439
C	3B	24	30.83	282.6	74.47	74.92	760.9	100.03	88.63	467.5	25.56	2180	446
A	21	30	52.25	283.0	74.48	74.20	765.5	100.20	94.60	715.0	25.72	1935	396
A	22	30	50.00	279.4	74.18	74.30	765.2	100.19	93.10	692.5	26.02	1941	398
A	23	30	48.75	288.6	74.94	75.10	765.2	100.19	94.10	679.5	25.25	2008	412
A	24	30	57.33	287.6	74.85	75.00	765.6	100.21	94.50	776.0	25.36	1942	398
A	26	30	58.82	283.0	74.54	74.60	765.3	100.20	93.90	834.5	25.66	2012	412
A	27	30	61.33	285.9	74.72	74.70	761.8	100.07	92.90	860.0	25.35	2016	413
B	59	30	48.82	291.7	75.22	74.60	770.0	100.37	93.94	705.0	25.15	2109	432
B	60	30	60.83	294.1	75.47	74.93	770.5	100.38	94.58	878.5	24.97	2104	431
B	61	30	51.50	288.6	74.94	74.78	765.6	100.21	94.33	749.5	25.24	2098	430
B	62	30	51.17	287.3	74.86	74.66	764.1	100.13	94.17	723.5	25.29	2034	416
C	101	30	50.75	279.4	74.19	74.43	759.6	99.99	95.29	762.4	25.80	2114	433
C	102	30	46.25	276.6	73.96	73.73	754.5	99.79	95.46	680.5	25.83	2067	423
C	8A	30	37.00	285.5	74.82	74.76	759.6	99.98	89.61	558.5	25.16	2201	451
C	1B	30	33.92	282.6	74.46	74.97	762.0	100.07	87.03	498.5	25.61	2115	433
A	29	48	57.42	288.6	74.94	74.55	761.0	100.03	92.60	678.0	25.10	1720	352
A	30	48	61.42	276.3	73.93	73.13	765.5	100.20	92.55	796.5	26.27	1802	369
A	31	48	54.08	277.2	74.01	73.81	758.5	99.94	91.45	631.5	25.93	1620	332
B	51	48	60.41	286.4	74.78	74.71	761.1	100.04	95.13	781.5	25.26	1858	380
B	52	48	55.67	280.6	74.29	75.75	762.7	100.10	95.24	671.0	25.81	1696	347
B	55	48	50.53	280.2	74.26	74.17	762.1	100.08	94.58	629.5	25.82	1758	360
C	58	48	50.08	275.6	73.84	72.19	761.3	100.05	93.65	672.0	26.21	1905	390
C	5B	48	42.72	281.1	74.36	75.78	763.1	100.11	94.56	538.0	25.75	1778	364
C	6B	48	41.83	281.0	74.35	75.69	762.8	100.10	94.89	530.0	25.75	1787	366
B	53	60	65.75	277.9	74.04	75.42	763.8	100.14	95.35	695.0	26.07	1473	302
B	54	60	70.42	285.2	74.68	75.15	767.8	100.29	94.84	707.0	25.61	1425	292
C	7B	60	43.50	295.8	75.55	76.28	764.2	100.15	94.36	437.0	24.60	1486	304
C	8B	60	44.67	294.8	75.47	76.92	763.7	100.13	85.08	456.0	24.56	1539	315
B	56	72	65.75	278.9	74.15	72.78	764.3	100.16	93.74	617.5	26.01	1314	269
B	63	72	52.00	286.3	74.77	74.85	767.7	100.28	93.05	430.0	25.51	1182	240
B	64	84	71.33	279.6	74.21	75.12	767.3	100.27	94.48	525.0	26.06	1030	211
B	65	84	68.08	283.4	74.53	75.96	766.2	100.23	93.03	490.5	25.70	1022	209
C	22A	3	43.75	288.5	74.96	73.82	764.9	100.18	94.56	115.5	25.22	385	79
C	23A	3	41.00	288.4	74.95	72.30	761.0	100.04	93.64	110.0	25.09	390	80
C	10B	6	52.00	285.6	74.72	75.06	761.0	100.04	91.24	297.5	25.32	828	170
C	12B	6	52.67	287.4	74.87	75.68	764.9	100.18	94.64	302.0	25.31	824	167
C	13B	6	42.33	293.6	75.37	75.48	759.2	99.97	94.80	258.5	24.60	902	185
C	107	9	41.00	289.5	75.04	74.47	760.1	100.00	94.43	385.0	24.96	1369	280
C	108	9	42.33	281.9	74.31	73.41	756.4	99.87	94.35	450.5	25.56	1514	310
C	9B	12	40.82	277.5	74.03	73.85	763.3	100.12	95.36	632.5	26.09	2156	441
C	9A	12	32.00	286.8	74.57	74.09	764.1	100.15	86.37	306.5	25.58	2261	463
C	12A	12	30.75	295.9	75.56	74.04	767.5	100.27	95.66	451.5	24.71	2151	441
C	13A	12	51.75	299.1	75.82	73.84	763.0	100.11	95.34	742.0	24.29	2144	439
C	14A	12	40.58	274.6	73.78	72.48	764.3	100.16	95.55	676.0	26.38	2292	470
C	15A	12	50.33	283.3	74.57	73.98	762.8	100.10	95.72	806.0	25.53	2281	468
C	10A	18	32.25	284.0	74.58	74.82	765.8	100.21	86.19	506.5	25.63	2263	464
C	11A	18	33.83	280.8	74.31	74.91	760.3	100.01	87.20	520.0	25.70	2230	457
Average....				283.9	74.57		763.3	100.11			25.54		

AVERAGES BY GROUPS

Series	Level	K	U	Series	Level	K	U
A	3	873	178	B-C	60	1481	303
A	6	2732	560	B	72	1248	254
A	9	2805	575	B	84	1026	210
A	12	2746	562	C	3	388	80
A	18	2418	496	C	6	851	174
A-C	24	2167	444	C	9	1442	295
A-B-C	30	2050	420	C	12	2214	480
A-B-C	48	1769	362	C	18	2246	460

TABLE II. HYDROSTATIC HEAD CORRECTION FOR LEVELS BELOW TOP TUBE SHEET

Average apparent temperature drop for all series $(b_1) = 25.54$.
Average body pressure for all series $(p_p) = 283.9$.
Corresponding temperature $(t_w) = 745.7$.
Average steam temperature for all series $(t_g) = 100.11$.

Series	A	A	A	A	A	A + C	C	C	C	C
Level, in. above bottom tube sheet	3	6	9	12	18	24	6	9	12	18
Heating surface above liquor level, H_a	3.540	3.161	2.779	2.401	1.643	0.882	3.161	2.779	2.401	1.643
Heating surface below liquor level, H_b	0.533	0.192	1.294	1.672	2.430	3.191	0.912	1.294	1.672	2.430
Hydrostatic head on bottom tube sheet, p_h	5.5	10.9	16.4	21.8	33.8	43.6	10.9	16.4	21.8	32.8
Total pressure on bottom, p_b	289.4	294.8	300.3	305.8	316.7	327.6	294.8	300.3	305.8	316.7
Temperature at bottom, t_b	75.03	75.49	75.94	76.37	77.22	78.05	75.49	75.94	76.37	77.22
Temperature drop at bottom, θ_2	25.09	24.62	24.17	23.74	22.89	22.06	24.62	24.17	23.74	24.20
Mean weighted temperature difference, θ_{mh}	25.51	25.43	25.32	25.16	24.74	24.12	25.43	25.32	25.16	24.74
Apparent K	873	2732	2805	2746	2418	2167	851	1442	2214	2246
Corrected K	875	2741	2830	2787	2495	2293	854	1453	2247	2317

rators is obvious. A hopper bottom is used on a vertical tube evaporator when the formation of crystals or precipitates is expected. But under these circumstances it is comparatively rare that a vertical tube evaporator would be operated at low liquor levels because of the danger of building up deposits on the heating surface. When an evaporator is run as salting evaporators usually are, with the liquor level at the top tube sheet, the effect of the cone bottom disappears. On the other hand, in evaporators for liquids which can be boiled at low liquor levels it is of importance to keep the volume of liquid below the bottom tube sheet as small as possible.

CALCULATIONS

To determine how much of the effect shown by these curves is actually caused by hydrostatic head, points were read off the curves as plotted and recalculated to actual conductivities as follows:

Let t_g = temperature of heating steam (calculated from pressure).

t_w = temperature of the boiling liquid at its surface (calculated from the vacuum).

t_b = temperature of the boiling liquid at the bottom tube sheet.

t_t = temperature of the boiling liquid at the top tube sheet.

$\theta_1 = t_g - t_w$ = temperature difference at the surface (apparent temperature difference).

$\theta_2 = t_g - t_b$ = temperature difference at the bottom tube sheet, corrected for hydrostatic head.

$\theta_3 = t_g - t_t$ = temperature difference at the top tube sheet, corrected for hydrostatic head.

θ_{mh} = mean weighted temperature difference, corrected for hydrostatic head.

p_g = absolute pressure in the vapor in mm. mercury.

p_h = head of liquid on the bottom tube sheet, mm. mercury.

p'_h = head of liquid on the top tube sheet, mm. mercury.

$p_b = p_g + p_h$ = total pressure at the bottom tube sheet in mm. mercury.

$p_t = p_g + p'_h$ = total pressure at the top tube sheet, mm. mercury.

H_a = heating surface above liquor level, sq.m.

H_b = heating surface below liquor level, sq.m.

Then to illustrate the derivation of the values in Table II, for hydrostatic heads below the tube sheet, the following computation is given:

$p_t = p_g = 283.9.$

$p_b = p_g + p_h = 283.9 + 43.6 = 327.6.$

$t_t = t_w = 74.57.$

$t_b = 78.05.$

$\theta_1 = \theta_3 = t_g - t_w = 100.11 - 74.57 = 25.54$ deg.

$\theta_2 = t_g - t_b = 100.11 - 78.05 = 22.06$ deg.

$\theta_{mh} = \dfrac{\theta_2 H_b}{H_a} + \dfrac{\theta_1 H_a}{H_b} = \dfrac{(22.06 \times 3.191) + (25.54 \times 0.882)}{4.073} = 24.12$ deg.

Then the corrected $K = \dfrac{\theta_1}{\theta_{mh}}$ (apparent K) $= \left(\dfrac{25.54}{24.12}\right) 2167 = 2293.$

For levels above the top tube sheet the calculation differs. The corrected temperature at the top tube sheet must be computed, and the arithmetical mean between this and the corrected temperature drop at the bottom tube sheet becomes the new mean (θ_{mh}) from which the corrected K is calculated. The following calculation is for a level 72 in. above the bottom tube sheet:

$p_t = p_g + p'_h = 283.9 + 76.5 = 360.4.$

$p_b = p_g + p_h = 283.9 + 131.1 = 415.0.$

From steam tables

$t_t = 80.38.$

$t_b = 83.91.$

$\theta_2 = t_g - t_t = 100.11 - 80.38 = 19.73.$

$\theta_2 = t_g - t_b = 100.11 - 83.91 = 16.20.$

$\theta_{mh} = \dfrac{\theta_2 + \theta_2}{2} = 17.96.$

Corrected $K = \dfrac{\theta_1}{\theta_{mh}}$ (apparent K) $= \left(\dfrac{25.54}{17.96}\right) 1248 = 1776.$

In taking θ_{mh} as the arithmetical mean the assumption has been made, to simplify calculation, that the boiling point of water is a linear function of the hydro-

TABLE III. HYDROSTATIC HEAD CORRECTIONS FOR LEVELS ABOVE TOP TUBE SHEET.

Average apparent temperature drop for all series $(t_1) = 25.54$
Average body pressure for all series $(p_g) = 283.9$
Corresponding temperature $(t_w) = 74.57$
Average steam temperature for all series $(t_g) = 100.11$

Series	A + B	A + B	B	B	B
Level, in. above bottom tube sheet..	30	48	60	72	84
Hydrostatic head on top tube sheet, mm., p'_h	0.0	32.8	54.6	76.5	98.3
Total pressure on top tube sheet, p_t	283.9	316.7	338.5	360.4	382.2
Boiling temperature at top tube sheet, t_t	74.57	77.22	78.84	80.38	81.84
Temp. drop at top tube sheet, θ_3	25.54	22.89	21.27	19.73	18.27
Hydrostatic head on bottom tube sheet, p_h	54.6	87.4	109.2	131.1	152.9
Total pressure on bottom tube sheet, p_b	338.5	371.3	393.2	415.0	436.9
Boiling temperature at bottom tube sheet, t_b	78.84	81.12	82.55	83.91	85.22
Temperature drop at bottom tube sheet, θ_2	21.27	18.99	17.56	16.20	14.89
Mean temperature drop, θ_{mh}	23.40	20.94	19.42	17.96	16.58
Apparent K	2050	1705	1475	1248	1026
Corrected K	2236	2065	1940	1776	1579

static head. This is, of course, not so, but for want of a simple equation expressing the relationship the above approximation is taken as true enough for our purpose.

The results are connected by the curve indicated in Fig. 1. Evidently the effect of hydrostatic head is subordinate to the effect of velocity of circulation. More detailed discussion of the effect of velocity is unprofitable until a considerable number of similar curves under different conditions of operation have been determined.

It should be emphasized that the elevation in boiling point, due to increased hydrostatic head, is not shown by a thermometer immersed in the lower part of the boiling liquid. In an evaporator of the type here used, where the descending circulation is in the outer annular down-take space, a thermometer inserted into this annular space should always read a temperature corre-
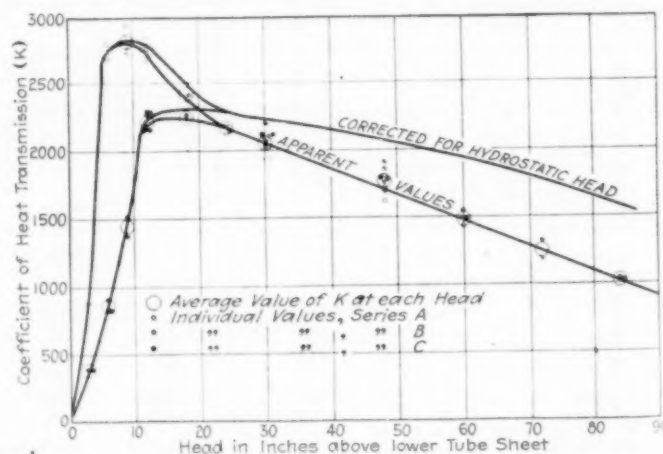
FIG. 1. VARIATION OF HEAT TRANSMISSION WITH HEAD

sponding to the vacuum or a little lower. The liquid in this down-take space is coming from the upper part of the evaporator, where it has lost any superheat it may have had, and must enter the down-take either at the temperature corresponding to the vacuum or at a lower temperature if it cools by radiation.

If the columns showing temperature calculated from vacuum and temperature of body are compared it will be seen that the temperature read by the thermometer tends to be lower than that calculated from the vacuum at low liquor levels and higher than that calculated from vacuum at high liquor levels. This thermomete

was situated not far from the feed inlet and consequently at low liquor levels (which mean high rates of evaporation and consequently high rates of feed in proportion to the total amount of liquid in the evaporator) ; it gives a low reading, due to currents of colder feed liquor. Through the middle of the range, where the effect of feed is less and yet circulation is strong, the two temperatures agree fairly well. At very high temperature levels there is very little real circulation, but rather an agitation or bouncing. This bouncing may at times result in some superheated liquid from the lower part of the steam basket being carried up into the annular space as far as the thermometer bulb. At ordinary levels and with ordinary circulation there will be no appreciable elevation of the general temperature of the boiling liquid.

CONCLUSIONS

The following conclusions must be for the present considered as indicating tendencies only, and should be applied with caution to evaporators which differ very much in design from the evaporator in which they were determined.

1. The maximum heat transmission when boiling water or other non-foaming, non-viscous materials in a vertical tube evaporator occurs when the tubes are from one-third to one-half submerged.

2. The position of this maximum point and its value depends on the size and shape of the evaporator bottom. With bottoms containing little liquid below the bottom tube sheet the maximum occurs at lower levels and has a higher value than with bottoms containing large amounts of liquid.

3. Differences in the shape of the bottom have little effect on heat transmission when the amount of liquid in the evaporator above the bottom tube sheet is larger than the amount of liquid below the bottom tube sheet.

4. As the liquor level is increased above the top tube sheet the heat transmission falls off along a straight line.

5. The change in heat transmission with changing liquor level is only partially due to the effect of hydrostatic head. Changes in velocity of circulation are a very important factor.

Step-Induction Regulator for Electric Furnace Voltage Control

FOR controlling the energy input for carborundum, graphite, aluminum, zinc and similar types of electric furnaces, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is manufacturing a step-induction regulator which gives a uniform voltage over a wide range. The regulator consists of a furnace transformer, an induction regulator, switches and push-button control. This apparatus utilizes the principle of varying the high-voltage tap on the transformer for controlling the energy input to the furnace.

The function of the induction regulator is to vary the voltage between taps. After the voltage of the adjacent tap is reached the selector and transfer switches automatically transfer the induction regulator so that it will function between the next two taps. One of the main features of this apparatus is that the entire voltage range is controlled by two push-buttons, one for boosting and one for bucking the voltage.

The construction of the apparatus is as follows: On the shaft of the regulator is geared a selector switch, the joints on this switch being connected directly to taps on the high voltage winding of the furnace transformer. The selector switch-arm moves from one contact to the next automatically as the induction regulator moves. The function of the feeder voltage regulator is to add to or subtract from the normal voltage of a transformer tap and is designed so that at the position of maximum boost it will add exactly one-half of the voltage between adjacent transformer taps, while at position of maximum buck it will subtract exactly one-half the voltage between adjacent transformer taps. Considering, then, a single position of the selector switch-arm, a single rotation of the moving coil of the induction regulator will vary the voltage impressed on the high tension winding from a position one-half step below to a position one-half step above the voltage point actually represented by the transformer tap. The selector switch arm is moved from one tap to the next just as the voltage one-half way between adjacent taps is reached, so that continued rotation of the regulator coil produces a continuous variation, raising or lowering the voltage depending only on the direction in which the regulator coil is being turned.

While the above is the fundamental operation of the apparatus, in actual practice there are slight modifications. The moving coil of the regulator makes but one-half revolution to go from the position of maximum
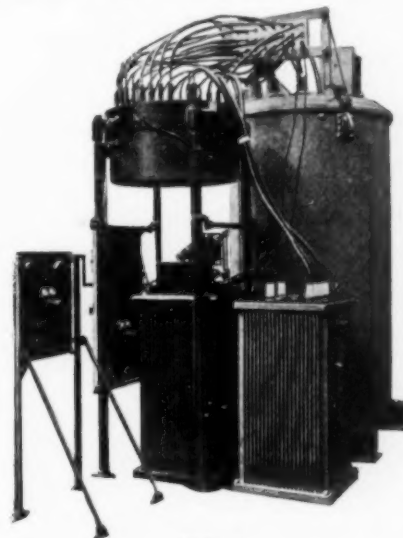
FIG. 1.
Step-induction regulator complete with transformer and control panel, 1,100 kva., 14,500 volts, single-phase, 25 cycle, low-voltage range, 40 to 50 volts.

buck to the position of maximum boost, at which latter point the selector switch moves to the next higher voltage tap, and the regulator must be brought at this point to maximum buck before it can, by continued operation, raise the voltage over another step. That is, at this point, the direction of current through the regulator coil must be reversed. Actually, the result is

obtained by a second coil of opposite polarity which is cut in at the proper time by a transfer switch and the regulator changes directly from maximum boost to maximum buck, so that continued rotation still acts to raise the voltage. The two-coil arrangement also makes desirable two-selector switches geared together for continued voltage variation. With high incoming line voltage a series transformer is interposed between the high tension line and the induction regulator. This allows the use of a less bulky low voltage induction regulator, and insures against trouble with insulating moving parts for high potentials. In this case, two coils are incorporated with the series transformer instead of in the regulator itself, and accomplish the same current reversing purposes. The operation of this regulator may be seen by reference to the schematic diagram.

Assume that the circuit is complete from the incoming high voltage positive line through one-half the high tension winding of the power transformer, through transfer switch T contact a to the upper coil of series transformer SR and through selector switch S to tap 1 on the other half of the high-tension winding, which is divided into equal voltage sections. The primary of the series transformer connects directly to the secondary or
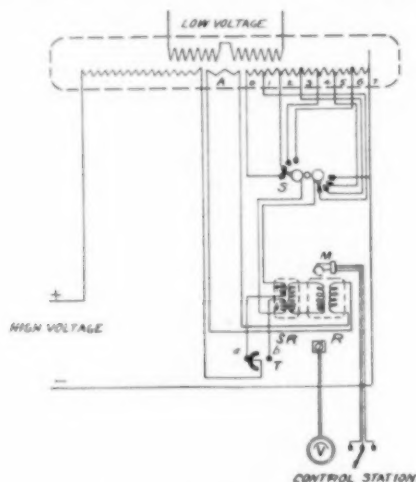
FIG. 2. DIAGRAM OF CONNECTIONS

moving element of the induction regulator R. The series transformer then serves only to insulate the induction regulator from high line voltage, any voltage variation due to induction regulator movement being reflected proportionately in the series transformer coil which is in series with the main supply line. The induction regulator, therefore, adds to or subtracts from normal line voltage in the same manner as though the series transformer were omitted. Assume that the induction regulator is in such position that no voltage is induced in its rotating element. Voltage then is neither added nor subtracted by the series transformer coil and line voltage is impressed across thirteen-fourteenths (one-half plus six-fourteenths) of the high-tension winding and the low-tension voltage will be fourteen-thirteenths of what it would be with the voltage impressed across the entire winding.

Turn the rotating element of the induction regulator from the neutral, and voltage will be induced in its secondary coil from the primary winding which is constantly excited from an auxiliary coil A on the power transformer. The induction regulator and series transformer combination is designed so that its maximum

voltage is equal to one-half the voltage difference between adjacent taps. Assume that the moving element is rotated so that the induced voltage adds to that of the line; evidently depending upon the amount of rotation from the neutral no-voltage position the effective voltage of the line may be raised from the normal voltage of tap 1 to any point up to a maximum corresponding to a voltage one-half way to tap 2. With coil rotation in the opposite direction, the induced voltage will subtract from the line, and continued movement of the coil will lower impressed voltage to a point corresponding to that one-half way to tap 0 on the transformer winding. In other words, the range of the induction regulator and series transformer combination itself is between adjacent transformer taps.

Consider now that the induction regulator has been rotated to its maximum boost position, while connected to tap 1. In effect a voltage one-half way between tap 1 and 2 is impressed upon the power transformer winding. Evidently the same result in voltage would be obtained if the coil of the series transformer were connected to tap 2 and the induction regulator was in its maximum buck position. With the coil voltage bucking, continued rotation in a boost direction would raise the voltage through the range of the induction regulator and progress over another step could be undertaken.

It is desirable, therefore, at the position of maximum boost to advance connections to the next higher voltage tap and simultaneously to change the induction regulator to give maximum voltage buck. This is accomplished by driving selector switch S and transfer switch T through gearing from the induction regulator shaft so that taps on the transformer winding are connected automatically and at the proper time polarity is changed from maximum voltage boost to maximum voltage buck. Continued rotation in one direction of the induction regulator raises the voltage over the entire range.

Any voltage within the range of the extreme taps on the transformer winding may be obtained by closing a two-way switch in either a "raise" or "lower" position, the voltage setting of the regulator being indicated by an adjacent voltmeter.

Difficulties of the German Paper Industry

According to a recent issue of *Kölner Zeitung*, the German paper industry is seriously handicapped by the scarcity and increased prices of raw materials. This is particularly true of old paper and rags, which are extremely difficult to obtain and have reached a price which appears unjustified. It is believed that old paper and rag dealers have been holding their supplies to drive prices up. The demand is very great and constantly increasing in spite of the fact that consumers believe present prices cannot continue. The cellulose plants in eastern Germany, which have been forced to suspend production for some weeks owing to the shortage of coal, have recently resumed operations, and it is hoped that renewed deliveries of cellulose will help to drive down the prices of old paper and rags. Straw, which is used in large quantities in the German paper industry, is now quoted at 55 to 60 marks per 100 kilos, but this price is expected to fall in the near future. It is hoped that this will also have an effect on the prices of other raw materials. Wages in the industry have risen over 100 per cent since December, and the cost of coal, chemicals, dyes and other raw materials has risen in like manner.

Synopsis of Recent Chemical & Metallurgical Literature

Synthetic Ammonia.—GEORGES CLAUDE has recently outlined the results of his work on synthetic ammonia before the Société Chimique de France and the Société d'Encouragement pour l'Industrie Nationale de France. He proposes the use of ammonium chloride instead of ammonium sulphate as fertilizer and stated that in the manufacture of the chloride for each kg. of fixed nitrogen produced it will be possible to obtain with practically no additional cost more than three tons of sodium carbonate. He reviews the history of the production of synthetic ammonia by the use of catalyzers and high pressures, and cites that the French chemist Tellier as late as 1867 was the first to make use of the affinity of iron for nitrogen. A few years later iron at red heat was used as catalyzer for the production of synthetic ammonia, but with little practical results.

It was due to the work of the German chemists Nernst and Haber based on the theoretical principles of the Frenchman Le Chatelier that synthetic ammonia can be produced now industrially and on a commercial scale. Nernst used iron as catalyzer with a 50 to 75 atm. pressure with encouraging but not economic results. Haber, with the financial help of the Badische Anilin, studied the catalyzing properties of uranium and osmium and succeeded in replacing iron as catalyzer by what the Badische Anilin calls activators. By the use of high pressures (200 atm.) and specially constructed machines it was possible for the Badische Anlin Co. in 1912 to realize large-scale production of synthetic ammonia, with its activators at red heat, and hydrogen from water gas at its Oppau plant.

Mr. Claude, studying further Le Chatelier's axiom that ammonia is formed with reduction of volume and that this formation is greatly facilitated by pressure, succeeded as late as 1917 in realizing his hyper-compressors for the production of 1,000 atm. pressure which now can compress 100 cu.m. of the mixture $N_2 + 3H_2$ per hour. The working of the apparatus is so simple that he was able to have a model in operation before his audience. He dwelt on the advantages in using hyper-pressures.

With the pressures used in Germany (200 atm.) the efficiency is 13 per cent, whereas with the pressure used by Claude the efficiency is 40 per cent. In both cases the use of a catalyzer is indispensable, and the temperature used is quite the same.

For a capacity of 100 cu.m. per hour per liter of catalyzing space the percentage of NH_3 can reach 25 per cent with the Claude process, as against 6 per cent with the Haber process, figures which correspond to a production of 6 g. instead of 0.5 g. per hour per gram of catalyzer.

In the German process the efficient combination of the gases takes place only by their passing a great number of times over the catalyzer and by the elimination of the NH_3 formed with water injected under pressure, whereas in the Claude process the gases once compressed are passed successively through three or four apparatuses in series and the pressure of the ammonia formed is still so high (250 atm. instead of the 12 atm. with the Haber process) that it is liquefied by its merely passing through a coil immersed in water.

Another advantage of the Claude process is that the product is liquefied NH_3 instead of an aqueous solution (Haber) from which the NH_3 has often to be recovered by distillation.

In the Haber process operating difficulties arise from the fact that the temperature must be increased by costly means. With the Claude process this is just the reverse, as the heat of reaction is even higher than that required and has often to be lowered. Under the operating conditions for synthetic ammonia it is certainly easier and more economical to lower the temperature than to raise it.

In the Haber process the production of the highly purified hydrogen requires enormous installations, whereas with the Claude process the hydrogen may be obtained by electrolysis of water or as a byproduct from coke-oven gas. This is a very important economic problem when it is considered that in the nitrogen fixation industry 1 part nitrogen requires 3 parts hydrogen. Mr. Claude is experimenting on a method by which to extract hydrogen from any hydrogen-containing gas mixture. If his expectations from this method are justified, as he thinks they are, it will be possible to install synthetic ammonia plants near coke ovens where at present immense quantities of hydrogen-containing gases are actually lost or badly utilized.

The advantages of the Claude process outlined above and other additional mechanical advantages and installation facilities warrant the statement that the Claude process is at present the most efficient and economical means of producing synthetic ammonia. The ease with which the process has been practically demonstrated before the audience is the best proof of its practicability. (*L'Industrie Chimique*, July, 1920.)

The Properties of Stoneware Clays.—Results of experiments conducted by the Bureau of Mines at its ceramic station at Columbus, Ohio, on the properties of some Ohio and Pennsylvania stoneware clays are described in Technical Paper 233, recently issued by the bureau, entitled "The Properties of Some Stoneware Clays," by H. G. SCHURECHT. The work has special reference to the possible use of these clays in making chemical stoneware, but many of the results brought out can be applied to other industries as well. It was conducted in co-operation with the Ohio Geological Survey, the Pennsylvania Geological Survey also assisting in collection of samples.

The resistance of vitrified clay to chemical action, together with its impenetrability to liquids, has made chemical stoneware an important product in the chemical industries. Stoneware distilling kettles, receivers, filters, condensing worms, centrifugal pumps, acid-proof pipe fittings, tower packing, acid-proof tanks, photographic tanks, and troughs and tubes for electrical processes are used in these industries. Stoneware equipment is also used in the preparation of foods, as, for example, sugar, flavoring extracts, and preserves. During the war, on account of the increased production of explosives and the production of poisonous gases, there was a marked increase in the demand for chemical stoneware and stoneware clays. A wider use of chemical stoneware is limited only by its comparative brittleness and sensitiveness to sudden temperature changes.

From each of the eleven clays tested, a series of seven bodies was prepared, the clay being ground to different grades of fineness and used alone and with varying proportions of feldspar, or feldspar and calcium carbonate added. From these bodies test pieces were prepared for which the drying shrinkage, tempering water, shrinkage water, pore water, rate of slaking in water, and transverse strengths in the green condition were determined for each body. The softening temperature and the porosity and volume shrinkage at various temperatures were determined by firing tests.

The results are tabulated in detail, and show a wide range of properties among the different clays tested. They indicate that some of the clays might be used for chemical stoneware.

Aluminum as Catalyst in the Preparation of Chlorbenzenes.

Chlorine combines directly with benzene under the influence of sunlight producing the α and β benzene-hexachlorides, but in the dark chlorination takes place only in the presence of a catalytic agent. The first catalyzer used was iodine, but JEAN MEUNIER has found that the catalytic action of aluminum is far superior to that of iodine and he presented the results of his work at the June 14, 1920, meeting of the French Academy of Sciences (*Comptes rendus*, vol. 170, No. 24. pp. 1451-2). He found that the best conditions for the preparation of chlorbenzenes, especially of the monochlorbenzene, is to use aluminum filings in the proportion of 1 part aluminum for 1,000 parts of benzene. During the chlorination the products obtained are C_6H_5Cl plus some more chlorinated benzene. When it is desired to produce only the monochlorbenzene it is necessary to stop the supply of chlorine when the density of the liquid reaches 1.008 at 15 deg. C., the density of the benzene being 0.876. The fractionation of this liquid made under reduced pressure and by heating on a water bath gives the following results:

	Per Cent
C_6H_5Cl (density 1.1084 at 11 deg. C.)	77
Light products (benzene and traces of C_6H_5Cl)	13
Denser products (dichlorbenzenes)	10

The light products are submitted to additional chlorination, giving 10 per cent C_6H_5Cl. The total efficiency of the process is thus 87 per cent.

Determination of Zirconium and Titanium in Zirconium Ores.

An article on "The Determination of Zirconium and Titanium in Zirconium Ores," by G. E. F. LUNDELL and H. B. KNOWLES, appeared in the July, 1920, number of the *Journal of the American Chemical Society*, pages 1,439-1,448. This article may be summarized as follows: Methods of decomposing zirconium ores are listed. A cupferron method for the determination of zirconium and titanium in zirconium ores is given. The method provides for the following elements which have been found in zirconium ores: Zirconium, titanium, silicon, thorium, cerium, iron, aluminum, scandium, yttrium, erbium, didymium, glucinum, calcium, magnesium, sodium, potassium, lithium, uranium, phosphorus, tantalum, manganese, zinc, cobalt, tin, lead, copper, and bismuth. It is also worthy of note that chromium and nickel do not interfere in a cupferron precipitation; that tungsten would not cause trouble since it is removed before the final precipitation; and that vanadium would require special treatment. Since this element has not been reported in zirconium ores, and since its presence in significant amounts would be indicated at various stages of the analysis, it would cause no trouble.

Recent Chemical & Metallurgical Patents

Manufacture of Bromates.

In the manufacture of bromides, solutions containing sodium bromide and sodium bromate are obtained. The best fractional crystallization of this mixture leaves a liquor containing the salts in the ratio of about 93 per cent NaBr to 7 per cent $NaBrO_3$. In order to effect a complete separation, COULTER W. JONES, of Midland, Mich., takes advantage of the relative insolubility of barium bromate, which is precipitated from the mixture by adding barium bromide:

$$2NaBrO_3 + BaBr_2 = Ba(BrO_3)_2 + 2NaBr$$

The alkali bromate may be reformed by treatment with alkali carbonate:

$$Ba(BrO_3)_2 + Na_2CO_3 = 2NaBrO_3 + BaCO_3$$

The barium carbonate is converted into bromide for use in the first step by hydrobromic acid or ferric bromide. (1,343,918; assigned to Dow Chemical Co.; June 22, 1920.)

Sodium Sulphite.

Calcium sulphite, which is a waste product in the manufacture of certain spray compounds and in the manufacture of magnesium chloride by certain processes, may be converted into sodium bisulphite by treatment with sodium bisulphate or niter cake:

$$CaSO_3 + NaHSO_4 = NaHSO_3 + CaSO_4$$

Milk of lime changes the acid sulphite into normal sulphite according to the equation:

$$2NaHSO_3 + Ca(OH)_2 = Na_2SO_3 + CaSO_3 + H_2O$$

(1,343,897; EDWIN O. BARSTOW, of Midland, Mich., assignor to the Dow Chemical Co.; June 22, 1920.)

Magnesium Arsenate.

Certain compounds of magnesium with arsenic acid are entirely suitable for insecticidal use and, according to EDWIN O. BARSTOW, of Midland, Mich., possess certain physical characteristics which render them equal to if not superior to lead arsenate and calcium arsenate. The preferred compounds, $MgHAsO_4$ and $Mg_3(AsO_4)_2$, may be prepared from magnesium hydroxide and arsenic acid or from magnesium chloride and sodium arsenate. (1,344,018, assigned to Dow Chemical Co.; June 22, 1920.)

Aluminum Nitride.

Briquets of finely-ground alumina and the calculated quantity of carbon are mixed with larger pieces of carbon in the form of coke, etc., and fed continuously through an electric furnace provided with stationary electrodes and an inlet for gas containing nitrogen, such as producer gas. The larger carbon pieces serve as resistors and carry most of the current required to heat the mass to the reaction temperature, at the same time separating the briquets and preventing them from fusing together. Owing to difference in size, the discharged mixture of briquets and resistors can easily be separated by screening. The resistors are used repeatedly until reduced in size by mechanical wear to a point where separation from the briquets becomes difficult. (1,344,153; MARK SHOELD, of Chicago, Ill., assignor to Armour Fertilizer Works; June 22, 1920.)

Electrolytic Oxygen-Hydrogen Generator.—Certain improvements in unit type oxygen-hydrogen generators are embodied in a cell designed by EDWARD O. BENJAMIN, of Newark, N. J. The diaphragm and all electrode surface exposed within the cell are completely submerged in the electrolyte, thus insuring the efficient functioning of these parts. There is no non-generating electrode surface to waste energy by reversing and acting as a gas battery. An additional advantage of such construction is its adaptability for use on shipboard. Since circulation of electrolyte through the diaphragm tends to impair its gas-proof qualities, provision is made for circulation of the electrolyte (due to difference in specific gravity of the electrolyte on opposite sides of the diaphragm) through suitable passages in the frame above and below the diaphragm. The circulation is slow and the passages are so constructed that there is no possibility of entrained gases passing from one side of the diaphragm to the other. Any number of cells may be connected in series by bolting together the side extensions on the plate electrodes. Should trouble develop, the cell or cells responsible may easily be short-circuited, disconnected and removed for repair without interfering with the operation of the remaining cells. (1,344,220; assigned to International Oxygen Co.; June 22, 1920.)

Synthetic Tanning Material. — Sulpho-phenol carboxylic acids and sulpho-cresol-carboxylic acids will yield condensation products with formaldehyde which are amorphous and water-soluble and which will produce a white, soft and strong leather when employed as tanning materials. (1,344,950 and 1,344,951; ARTHUR KOETZLE, of New York, N. Y., assignor to Rohm & Hass Co.; June 29, 1920.)

British Patents

Ammonium Sulphate.—Dry neutral ammonium sulphate is manufactured by treating the commercial salt with a neutralizing agent and simultaneously to agitation and drying under the action of heat, a granular or pulverulent product being obtained if the material is also subjected to treatment to effect mechanical reduction, while if the treatment is effected under suitable conditions, for instance in a partial vacuum or in a gas current, the pyridine is removed and can be recovered. The neutralizing agents mentioned are lime, magnesia or other alkaline earths or their carbonates, alkalis or their carbonates, ammonia, or suitable ammonium salts such as the carbonate, sulphide or sulphite. They may be added dry or as solutions or suspensions, and ammonia may be used in the form of gases, such as coal-gas, containing it, which, if hot, may effect the drying. The apparatus employed may contain grinding bodies, such as balls or pebbles. The gases escaping from the apparatus may be treated for instance with an absorbent such as water, acid solution or an oil or may be submitted to condensation, in order to recover pyridine and any escaping ammonia. In an example, the ammonium sulphate is treated with a small quantity of lime or of ammonia liquor in an externally heated ball-mill. Air is then blown or sucked through, the escaping gas being washed in a scrubber supplied with acid solution of ammonium sulphate such as a saturator mother-liquor. When a product is desired free from pyridine, the quantity of the neutralizing-agent should be equivalent to the quantity of the free acid plus the acid combined with the pyridine. (Br. Pat. 141,787—1919. S. E. LEOD-HOLT, Buckhurst Hill, Essex, and R. LESSING, London, June 23, 1920.)

Ammonium Sulphate.—Dry and neutral ammonium sulphate is prepared from the sulphate obtained by passing ammonia into sulphuric acid, by neutralizing in known manner the crystals separated in an acid condition from the liquor, and then drying them at a raised temperature, for example by causing the crystals to descend a tower up which heated air is passed. The dry and neutralized sulphate so obtained may be afterwards crushed. (Br. Pat. 141,798—1919. SOUTH METROPOLITAN GAS CO., E. V. EVANS and H. HOLLINGS, London, June 23, 1920.)

Production of Oxides of Tin and Zinc.—Oxides of tin and zinc are produced by supplying a blast of air under high pressure, say 4 or 5 lb., into the melted metal, and a blast of air under low pressure, say 0.15 to 0.5 lb., above the surface of the metal, auxiliary heating by an oil burner being employed if necessary. The oxide is carried off by the blast and collected. The apparatus consists of a tilting furnace a on trunnions b, Fig. 1, or rollers g^1, Fig. 3, having an oil burner c, a low-pressure blast d or d^1, and a high-pressure blast e, which may be provided with a rod e^3 to keep the opening clear. In the arrangement shown in Fig. 1, the furnace is heated and charged while horizontal, and is then tilted as shown in dotted lines to bring the open end a^3 opposite the low-pressure blast d and submerge the high-pressure blast. In the arrangement shown in Figs. 2 and 3, two high-pressure blasts e^4 are provided at opposite sides, the

FIG.1.

FIG.2.   FIG.3.
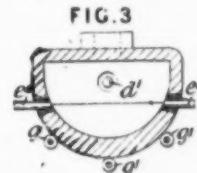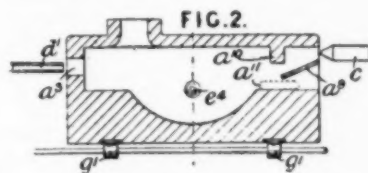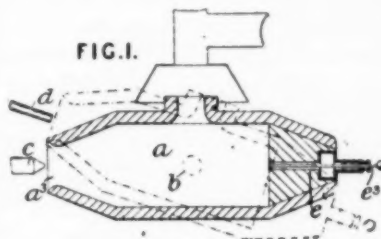
furnace being tilted so that first one and then the other is submerged. A screen a^9 is arranged below the burner c, and a baffle a^{10} directs the flame downward. Ingots a^{11} of metal are fed in beneath the screen a^9 without allowing the fumes to escape. In an arrangement of this kind, the low-pressure pipe d^1 may be dispensed with, the opening a^3 then being plugged, and the low-pressure blast is sent in through the burner c. The temperature can then be controlled by regulating the proportions of air and oil admitted through the burner. (Br. Pat. 142,157—1919. H. MACONOCHIE, London, and D. DE ROS, Greenhithe, Kent, June 30, 1920.)

Recovery of Nickel Oxide From Alloy or Scrap.—Copper-nickel alloys or metallic scrap are treated for the recovery of nickel oxide by melting in a basic reverberatory furnace or in a basic converter, and air is blown on to the surface or through the molten mass. Nickel oxide volatilizes and is recovered, for instance, in a bag-house or by electric precipitation. (Br. Pat. 142,310—1919. A. McKECHNIE and McKECHNIE BROS., London, June 30, 1920.)

Fatty Acids; Soaps.—Fatty acids containing a number of double linkages are converted into fatty acids resembling oleic acid by saponifying them for their glycerides, and heating the resulting neutral soaps to 210-250 deg. C. without evaporation to dryness. The product may be treated with mineral acid to isolate the fatty acid, or may be used as soaps if alkalis are used as saponifying agents. If alkaline earths are used for saponification, the products may be treated with alkali carbonates for the production of soaps. As raw material, sesame or cottonseed oil or the fatty acids therefrom may be employed. (Br. Pat. 141,720—1919. PERSAPOL GAS, Hanover, Germany, June 19, 1920.)

Hydrogen Peroxide.—An alkaline persulphate, e.g. ammonium persulphate produced electrolytically, is separated from the greater part of the electrolyte by means of a vacuum or centrifugal filter, and is placed in a steam-jacketed horizontal tube into which steam is introduced and which is connected through the medium of a condenser to a vacuum pump. The hydrogen peroxide produced collects in the condenser, and the residue of alkali bisulphate remaining in the tube, after dissolving in a quantity of water, can be returned to the electrolytic chamber, since the ratio of base to sulphuric acid has not been changed. (Br. Pat. 141,758—1919. L'AIR LIQUIDE SOC. ANON. POUR L'ETUDE ET L'EXPLOITATION DES PROCÉDÉS G. CLAUDE, Paris, France, June 16, 1920.)

Ammonium Sulphate.—The acid usually present in ammonium sulphate is removed by washing the sulphate at a raised temperature with a solution of ammonia obtained by condensing the vapors from a fixed ammonia still and diluting the solution thus obtained to such a strength that, at the temperature at which it is to be used, the vapor pressure of the ammonia is too low to entail substantial loss of ammonia. By washing at a raised temperature, chilling of the ammonium sulphate crystals, which might lead to the choking of the centrifugal, is avoided. A suitable diluent for the ammonia solution is obtained by subjecting the hot waste liquor from the fixed ammonia still to a slightly reduced pressure, and condensing at a suitable temperature the mixture of steam and ammonia withdrawn. (Br. Pat. 141,819—1919. SOUTH METROPOLITAN GAS CO., London, P. PARRISH, London, W. A. M. VALON, Stafford, June 23, 1920.)

Plastic Compositions.—A plastic composition which is a non-conductor of heat and electricity and is incombustible, is formed by mixing fibers of paper, wood, rag, etc., plaster, and a solution of gelatine containing stannic oxide. The mixture is heated with a solution of formaldehyde or of sodium bichromate. Colors may be added. An example of proportions is 25 parts of fiber, 175 parts of plaster, 45 parts of gelatine, 10 parts of tin dioxide and 110 parts of water mixed with 5 parts of formalin or sodium bichromate in 30 parts of water. (Br. Pat. 141,987—1919. L. DELECLISE, Boulogne sur Mer, June 23, 1920.)

Basic Magnesium Hypochlorite.—When chlorine is passed into an aqueous suspension of magnesium oxide, basic magnesium hypochlorite is precipitated, provided that for every molecule of normal hypochlorite produced, more than two (preferably five to six) molecules of magnesia remain unattacked. The most favorable temperature for the process is 20-22 deg. C. Practically the whole of the available chlorine is absorbed by the pre-cipitate without any appreciable production of chlorate if, after the introduction of the chlorine, the reacting mixture be allowed to stand for a considerable time, or be heated to 80 deg. C. and kept at that temperature for from 6 to 8 hr. in the dark. The precipitate, after washing well with hot water, is dried with exclusion of carbon dioxide. (Br. Pat. 142,081—1919. G. KERESZTY and E. WOLF, Budapest, Hungary, June 23, 1920.)

Vulcanizing India Rubber.—In the vulcanization of rubber compounds by hot air, litharge or its derivatives are replaced by an organic or inorganic reducing agent to obtain a light-colored product. Suitable reducing agents are hydroquinone, pyrogallol, tannins, paramidophenol, glycerine, trioxymethylene and other derivatives of formaldehyde, hydrosulphites, neutral sulphites. In general, the amount of reducing agent should not exceed 10 per cent of the rubber. (Br. Pat. 142,083—1919. A. H. HELBRONNER, Paris, June 23, 1920.)

Cracking of Hydrocarbons.—In the cracking of hydrocarbon oils, the thermal decomposition of fats to obtain glycerine, the production of oil and coal gas, and the destructive distillation of coal, peat, shale, etc., the lower molecular weight products are separated, while the higher molecular weight products and undecomposed substances are retained for further exposure to the decomposition conditions, by interposing one or more porous septa between the decomposition chamber and the condenser or receiver. The decomposition conditions may be maintained up to the porous septum; but it is preferred to place the porous septum in a separate chamber inside or outside the decomposition vessel; and a plurality of diffusion chambers may be used arranged either in series or in parallel. The invention is applicable to processes carried out either in the vapor or liquid phases; and in the former case, the removal of the vapors is facilitated and controlled by lowering the pressure on the condenser side of the septum with respect to that on the other side. (Br. Pat. 142,206—1919. W. MANN, London, June 30, 1920.)

Alkali Cyanides.—Alkali cyanides are obtained by reacting upon carbon and nitrogen with an alkali metal and an alkali metal compound. The alkali metal, such as sodium, may be used in the form of vapor, which may be mixed with carbon monoxide, and may be used to suck in the powdered alkali metal compound, such as soda. The alkali metal compound may be used in powdered or liquid condition, and may be introduced with the charge of carbon. (Br. Pat. 142,122—1919. H. MEHNER, Berlin, June 30, 1920.)

Hardening and Tempering.—Relates to means for hardening and tempering a nickel-chromium steel armor-piercing projectile having zones of steel of successively increasing hardness toward the point. The projectile, which is made of steel containing 0.58 to 0.7 per cent of carbon, 2 to 3.5 per cent of nickel and 2 to 3 per cent of chromium, is heated all over to 800-860 deg. C. and dipped point downward to its base in water until properly hardened, when it is removed and tempered by heating to a base temperature of about 760 deg. C. and an internal temperature of about 575-700 deg. C., while the head is immersed to a small depth in water; it is then cooled in the tempering plant to an internal temperature of 320-120 deg. C., after which it is cooled to atmospheric temperature. (Br. Pat. 142,143—1919. Sir R. A. HADFIELD, Westminster, A. G. M. JACK, Sheffield, and I. B. MILNE, Totley, Derbyshire, June 30, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Chemical Warfare Officers' Reserve Corps

Second in importance only to the establishment of the Chemical Warfare Service as a separate entity within the War Department was the order of the Secretary of War dated Aug. 24, 1920, authorizing the immediate formation of a Chemical Warfare Officers' Reserve Corps. General Amos A. Fries, Chief of the Chemical Warfare Service, announces that he will begin the formation of the Reserve Corps at once. He hopes to be able to obtain the assistance of some of the officers who will enter the Reserve Corps to assist in the organization work.

"This Reserve Corps means," said General Fries, "that the Chemical Warfare Service will know where to put its hand on two thousand chemical warfare officers in case of an emergency. Each member of the Reserve Corps will be classified carefully as to his specialties and other qualifications. This will permit their being called into service only as needed.

"The Reserve Corps not only will put the Chemical Warfare Service in a position to render most efficient work, but it will provide a highly necessary step in the interest of the national defense."

The fact that reserve officers may not be called into service in peace time without their consent and the fact that the Chemical Warfare Service is a separate subdivision of the War Department remove the principal objections to membership in the corps. During the time the placing of the Chemical Warfare Service in the Quartermaster Corps was being considered, many former chemical officers objected to entering the Reserve Corps, since there was no assurance that they would not be detailed to any duties in the Quartermaster Corps.

It is the hope of General Fries that he will be able to draw officers from the Reserve Corps for short periods of duty. He believes that many chemists would be willing to spend their vacation periods on duties pertaining to the work of the service. During such temporary duty the reserve officers would receive the pay of their rank and would be given mileage.

Chemists Perfect Process of Protecting Raw Sugar From Mold and Bacteria

According to a bulletin of the Louisiana Sugar Experiment Station in New Orleans, Dr. Nicholas Kopeloff and Mrs. Lillian Kopeloff, bacteriologist and assistant bacteriologist, have completed a method of preventing deterioration of sugar by molds and bacteria.

It is estimated that about 70,000,000 lb. of the Cuban sugar, valued at $1,500,000, or enough sugar to supply 873,000 persons for one year, is destroyed annually by the activity of these organisms.

Dr. and Mrs. Kopeloff, by making bacteriological examinations at every stage of the sugar-making process, have found that sugar deterioration can be prevented by substituting dry or super-heated steam for water in the final process of washing sugar in the drums in which sugar is dried. The centrifugals in their whirling suck up from the floor air which may be contaminated with germs. Also it is common practice to make the color of the sugar lighter by washing the crystals with water which may be contaminated with molds and bacteria.

In the new process it is shown that dry steam is successful in killing over 99 per cent of these avid molds and bacteria.

Water-Power Act Regulations

Due to the length of time required to develop the actual wording of the water-power act regulations which would be satisfactory to all concerned it has been decided to issue a statement of principles. The exact language of the regulations then can be worked out more leisurely. It is expected that another public hearing will be held to go over the final draft of the regulations before their promulgation. This arrangement will allow the committee representing outside interests, of which F. H. Griffith is chairman, to disband for the present.

The Federal Power Commission conducted a hearing on Aug. 24 on the Great Falls project. The water-power act provides that a report must be made before Jan. 1 on this project, which is being relied upon to furnish power for the District of Columbia and for the development of industrial areas in nearby portions of Virginia and Maryland.

All witnesses urged the development of Great Falls except the representative of the Potomac Electric Power Co., who contended that the commercial development of the falls under present conditions would not be feasible.

Difficulties in Obtaining Balloon Gas

The international balloon races which were planned for last month in Indianapolis have been somewhat delayed by the inability to secure the necessary balloon gas at this location. The Air Service is now seeking a new location at which adequate facilities will be available.

The gas required is, of course, one of low specific gravity in order to give high lifting power. Stripped run-of-oven byproduct gas, special coal gas made at high temperature to give low specific gravity, or uncarbureted water gas are the usual supplies employed for these purposes. Gas of a gravity of approximately 0.40 or slightly less is desired for the type of free balloon which is to be used by the contestants. If other means fail, it may be necessary to produce this supply by adding hydrogen to city gas supplies. The hydrogen thus used would have to be manufactured in the portable-type ferrosilicon plants used as field equipment by the Air Service.

Steel Treaters' Convention and Exhibit

A joint meeting of the consolidated American Steel Treaters' Society and the Steel Treating Research Society will be held at the Commercial Museum, 34th and Spruce Sts., Philadelphia, Pa., from Sept. 14 to Sept. 18 inclusive. Throughout the same week and in the same building the societies will sponsor an exhibit of heat-treating appliances and heat-treated products, over 130 firms occupying about 80,000 sq.ft. of floor space. In view of the great success of a like exhibition held last year in Chicago, and the preliminary space reservations, this feature of the event will be of the greatest interest and advantage to the metallurgists in attendance.

Mrs. D. K. Bullens is chairman of the Ladies' Entertainment Committee, and many sight-seeing and social events are being planned. Prominent among them will be trips to historic spots in the vicinity, inspections of Wanamaker's, Curtis Publishing Co., and the Navy Yard.

The exhibition will be open daily from 9 a.m. to 10:30 p.m. Two-hour technical sessions will be held each morning, afternoon and evening on Tuesday, Wednesday and Thursday, except on the latter day, when an informal banquet and entertainment will be given at the Bellevue-Stratford. Friday and Saturday are reserved for inspection trips.

A partial list of the authors and papers follows:

CARBONIZING

"High Temperature-Resisting Alloys for Carbonizing," by A. Bensel.

"Proper Heat Treatment for Carburized Steel Parts," by Louis A. Ellner.

"Heat-Resisting Metals," by G. W. Franzheim.

"Rapid Carburizing, Hardening and Tempering of High Carbon Alloy Steels," by R. L. Gilman.

"Containers Used in Heat-Treatment Processes," by H. H. Harris.

"Proper Carburizing Temperature," by C. A. Haux.

"Heat-Treated Flame and Acid-Resisting Steel," by Charles M. Johnson.

"Carburizing Thin Stock," by R. B. Kerr.

"A Research in Case Carburizing," by G. S. McFarland.

"Action of Cyanide in Case Hardening," by G. R. Brophy and Miss S. B. Leiter.

"Case Hardening," by Theo. G. Selleck.

ALLOY STEELS

"Effect of Zirconium and Cobalt on Steel," by J. Culver Hartzell.

"Molybdenum Steel," by R. L. Herrick.

"Stainless Steel," by W. H. Marble.

"Open-Hearth Steel vs. Crucible Steel," by George Porteous.

HARDENING

"Relation of Time, Temperature, Mass and Surface to Hardening," by Eric E. Bilgart.

"Quenching Tank for Tool and Die Work," by N. E. Brown.

"Progress in Small Shop Hardening Methods," by O. C. Hedin.

"Efficiency of Various Quenching Mediums," by V. E. Hillman, W. G. Lottes and J. B. Morey.

GENERAL HEAT TREATMENT

"Factors Governing Production of Heated Product," by J. A. Brown.

"Heat Treatment of High Tensile Steels," by A. K. Drury.

"Heat Treatment of a High-Chromium Steel," by H. J. French.

"Ordnance Work Applied to Peaceful Uses," by F. V. Larkin.

"Annealing and Heat Treatment of Miscellaneous Steel Castings," by Charles Ring.

"Effect of Heat Treatment Upon Fatigue Strength," by E. P. Stenger.

"Heat-Treated Parts in Locomotive Service," by A. F. Strubing, C. B. Peck and J. C. Marsh.

"Effect of Repeated Heat Treatment Compared to Extended Heat Treatment," by A. Tabachnick.

"Practical Aid to Treatment," by W. R. Ward.

"Commercial Heat Treating," by J. A. Wilson.

FORGINGS

"Forging Temperatures," by Peter Chambers.

"Treatment of Axle Forgings," by H. E. Hemstreet.

"Forging of Chrome: Nickel Steel Spindles," by H. B. Smith and F. J. Olcott.

"Forging Light Steel," by Robert B. Pottinger.

TOOL STEEL

"Working Test of High-Speed Steel," by A. H. D'Arcambal.

"Hardening Small Tools by Molten Lead," by W. F. Newhouse.

"Selection of High-Speed Steels," by Henry Traphagen.

"Hardening, Quenching and Tempering High-Speed Steels," by A. E. Bellis.

"Heat Treatment of High-Speed Steel," by J. L. Thorne.

OTHER DISCUSSIONS

Furnace design and fuels will be discussed from different angles by T. F. Baily, James Brakes, Jr., E. F. Collins, William A. Ehlers, W. O. Kellogg, W. H. Lyman, G. H. Trout, Henry Voltman, W. H. Weigand, H. P. MacDonald and Edward F. Davis.

Various phases of pyrometry will be discussed by J. D. Andrews, Arthur N. Armitage, H. G. Hall, Carl C. Jensen and F. J. McIntyre.

MISCELLANEOUS

"Relation of the Steel Salesman to the Development of Heat Treatment," by Guy B. Bible.

"Functions of a Chemist and Metallurgist," by C. U. Geesey.

"Factors Limiting Strength of Materials," by I. T. Hook.

"Injecting Salesmanship Into Metallurgy," by G. W. Keller.

"Oxidation During Heating," by H. O. Loebell.

"High-Grade Helical Springs," by T. A. Lynch.

"Relation of Metallurgical Laboratory to Inspection Department," by Marshall Medwedeff and E. W. Pierce.

"Recent Testing Machines, by T. Y. Olsen.

American Institute of Fertilizer Chemists

The first meeting of the American Institute of Fertilizer Chemists since its organization in June at White Sulphur Springs, W. Va., at the annual sessions of the National Fertilizer Association, took place at the Southern Hotel, Baltimore, on Aug. 2 and 3.

Dr. Frank G. Parker, of Charleston, the president, occupied the chair. Others present were: A. G. Stillwell, New York, vice-president; W. J. Gascoyne, Jr., Baltimore, treasurer; Samuel W. Wiley, Baltimore, secretary; Thomas C. Law, Atlanta; Charles W. Rice, Columbia, S. C.; Philip McG. Shuey, Savannah; Ralph W. Bailey, New York; Philip E. Chazal, Charleston; B. H. Morrison, Philadelphia.

At this meeting the work to be done by the institute was discussed at length. The purposes of the organization are to engender among fertilizer chemists a closer and more harmonious relationship; to impress upon the fertilizer trade the fact that the "independent" laboratory is all that the name implies, and that the members of the institute are bound by a code of ethics as rigid as that of other professional bodies, with the penalty of expulsion for transgressions; to provide a means for the members to confer and co-operate in minimizing discrepancies due to personal differences in technique and to secure from fertilizer manufacturers more careful attention to the obtaining of accurate samples of materials for analysis.

A pamphlet giving directions for the correct sampling of the various fertilizer materials will be prepared. The institute will also endeavor to bring about more efficient methods of chemical control at fertilizer plants.

Novel Repair Process

Among the novel repair processes developed by the war is the electrolytic deposition of a thin layer of iron up to one-twelfth of an inch thickness on any simple cylindrical surface of wrought iron or mild or cast steel. Describing the method to the British Institution of Automobile Engineers, B. H. Thomas states that the iron is deposited directly on the surface without any intermediate film of copper, and can be heated to redness without apparent deterioration, can be carbonized or hardened in the ordinary way, can be filed and ground, and takes a high polish. The work being properly done, the adhesion was so strong that the film could not be chipped away from the metal beneath with hammer and chisel. In a heavy repair shop the motor vehicle parts reclaimed in this way included stub axle arms, steering swivel pins, brake and clutch shaft ends, change speed lever shafts, insides of wheel hubs, outside of axles, tubes and universal joint pins. The wearing qualities of the deposit on a high-speed journal do not appear to have been determined. So far the process cannot be used for cast iron or aluminum and its value would be much increased if it could give an adherent coating to such parts as worn gear boxes and ball-race housings.

Groves Endowment Fund for Scientific Research

Charles Edward Groves, F.R.S., editor of the *Journal* of the London Chemical Society from 1884 to 1899 and vice-president of the society from 1899 to 1902, who died on Feb. 1, aged seventy-nine, has left £10,000 to the Royal Institution for the "Groves Endowment Fund" for the promotion of scientific research, to take effect on the death of the last surviving member of his family.

Canada's Sugar Industry

In a recent report of Consul Johnson, stationed at Kingston, it is stated that Canada has eight sugar plants in her provinces, which have a combined annual output of over 650,000,000 lb. Three of these plants are situated in the Province of Ontario, two in Quebec, and one each in British Columbia, New Brunswick and Nova Scotia.

The amount of capital invested in the sugar industry for the whole of Canada in 1918 was $37,256,851, divided among land, buildings and fixtures, $17,733,990; machinery and tools, $6,108,445; materials, stocks in process, finished products, fuel and miscellaneous supplies on hand, $6,511,626; and cash operating accounts, etc., $6,902,790. The Ontario plants represented an investment of $11,407,382, those of Quebec, $5,869,592 and the remaining provinces, $19,979,877.

The accompanying tables show the quantity and value of material used at the plant in 1918 and the quantity and value of the finished products:

QUANTITY AND VALUE OF MATERIAL

Classes of Materials	Tons	Cut Value at Works
Beets	204,017	$2,593,715
Raw sugar	313,651	39,991,144
Bone black and other materials		529,059
Boxes, bags and other containers		2,289,119
Total value		$45,403,037

QUANTITY AND VALUE OF FINISHED PRODUCTS

Kinds of Products	Quantity	Value
Sugar, granulated, lb	651,940,965	$57,080,353
Molasses or sirup, gal	1,559,694	1,016,626
Beet pulp, tons	11,069	411,645
Lime, bushels	22,590	6,250
Fertilizers, tons	1,284	43,075
Cattle food		151,776
All other products		102,494
Total value		$58,812,219

Japanese Exports of Calcium Carbide

Due to war conditions the exports in 1918 of calcium carbide, which is shipped chiefly to Australia, British India and China, amounted to 28,844,680 lb., valued at 5,476,000 yen, the 1919 exports falling to 3,399,904 lb., valued at 525,240 yen, while the 1920 exports run about the same as in 1919. As electric power costs at least 8 sen per kw., the cost of production of calcium carbide is about 5 sen per lb., and it is believed that unless the cost of electric power is reduced to less than 7 sen per kw. and the calcium carbide is improved in quality the Japanese product will find difficulty in meeting foreign competition.

Movement of Nitrate of Soda

During June, 109,953 tons of nitrate of soda moved through the Panama Canal. With the exception of three cargoes, which went to the United Kingdom, all of the nitrate was consigned to Atlantic ports of the United States.

Four cargoes of sulphur from the Louisiana and Texas fields passed through the canal during June destined to Portland, Ore., Vancouver, B. C., and Melbourne, Australia.

Tests Made of Firebricks

Tests made at the Columbus Experiment Station of the Bureau of Mines have developed the fact that firebrick with the highest alumina content last longest when used in malleable iron furnaces. Hot crushing strength tests were made of a number of varieties of firebrick.

Personal

P. W. BOUTWELL, assistant professor of agricultural chemistry at the University of Wisconsin, Madison, Wis., has been appointed associate professor of chemistry at Beloit College, Beloit, Wis.

Dr. F. G. COTTRELL, the director of the Bureau of Mines, in order to determine the moot question of the subjects to be handled at the new Mine Experiment Station at Tuscaloosa, Ala., will confer with the officials of the University of Alabama about the middle of September and gather first-hand information as to what subjects had best be handled at this station.

T. LINSEY CROSSLEY has become editor of the *Canadian Chemical Journal*, which is the official organ of the Canadian Institute of Chemistry.

R. E. DOOLITTLE spoke before the Chicago Chemists' Club recently on "Botulism and Proper Preparation of Ripe Olives."

General AMOS A. FRIES, chief of the Chemical Warfare Service, and Colonel E. J. Atkisson, the commander of Edgewood Arsenal, along with four or five other officers of the Chemical Warfare Service, will attend the meeting of the American Chemical Society in Chicago.

M. J. GAVIN, refinery engineer of the U. S. Bureau of Mines, who has been in Washington, has returned to his station at Salt Lake City.

RALPH A. GOULD, chemical engineer, 216 Pine St., and BRYANT S. DRAKE, chemical engineer, 14 Montgomery St., San Francisco, Cal., announce their association, from Aug. 1, 1920, in a partnership under the name of Gould & Drake, chemical engineers, with offices at 216 Pine St., San Francisco, Cal.

ERNEST J. HOPKINS, who recently resigned as assistant chemist, U. S. Bureau of Mines, Pittsburgh, Pa., has accepted a position in organic research with W. B. Pratt, Inc., Boston, Mass.

Dr. DAVID KLEIN, who was formerly associate professor of biochemistry in the Johns Hopkins University School of Public Health and Hygiene, is now with the Hollister-Wilson Laboratories, Chicago, Ill., as director of research and control laboratories.

A. T. MARCH has recently returned from Namtu, Upper Burma, India, where he has for the past several years been in charge of the silver refining for the Burma Mines, Ltd.

H. B. NORTHRUP has resigned his position as associate professor of metallurgy at the Penn State College, State College, Pa., to become chief metallurgist for the Diamond Chain & Mfg. Co.

ROBERT J. QUINN has recently severed connection with A. Daigger & Co. to become associated with the Mathieson Alkali Co., of Chicago, as district manager. Mr. Quinn is a graduate of chemical engineering at the University of Illinois, was subsequently chief chemist with Morris & Co., packers; later he became associated with the Wahl Henius Institute, consulting engineer in charge of packing department, and left to take a position with the Midland Chemical Co. His new address is 617 Webster Bldg., Chicago, Ill.

Dr. J. H. RANSOM, director of chemical research at the Michigan Smelting & Refining Co., Detroit, Michigan, recently delivered a lecture on non-ferrous alloys before the students of the school of chemical engineers, Purdue University.

RICHARD R. REES, who was formerly chief metallurgical chemist at the U. S. Arsenal, Watervliet, N. Y., and not chief metallurgist as erroneously given in this column in our last issue, is now with the Neptune Meter Co., Long Island City, N. Y.

Dr. WALDEMAR T. SCHALLER has severed his connection with the Great Southern Sulphur Co., Inc., of New Orleans, La., and has returned to the U. S. Geological Survey, Washington, D. C.

C. N. SHUETTE, recently superintendent of the Mariscal quicksilver mine in Texas, has rejoined the staff of the U. S. Bureau of Mines at Berkeley, Cal.

Dr. E. WARD TILLOTSON of the Mellon Institute is accompanying the members of the Institute of Glass Technologists who are here from England on their itinerary to the glass factories of the Eastern United States.

R. M. WILHELM, who has been chief of the thermometer laboratory of the National Bureau of Standards, has resigned to accept a position with C. J. Tagliabue Manufacturing Co., Brooklyn, N. Y. Mr. Wilhelm will begin work in his new position about the first of September.

W. WOODWARD WILLIAMS has resigned as vice-president of the Redding Iron Co. effective Sept. 1, when he will become assistant to the president of the Pittsburgh Gage & Supply Co.

Obituary

REGINALD K. PIERCE, secretary of the Semet-Solvay Co. and of the Kentucky Solvay Co., in an attempt to avoid an accident was killed near Oran, N. Y., on Sunday evening, Aug. 15, while driving a high-powered roadster which turned over in a ditch as he tried to avoid a collision with a smaller machine. Mr. Pierce was instantly killed. He was a brother of Edward L. Pierce, president of the Semet-Solvay Co. and the Kentucky Solvay Co., and had been associated with these companies for about twelve years, holding several important offices. He was elected secretary and sales manager of the companies about three years ago and was serving in these capacities at the time of his death. He was forty-two years old. He leaves three brothers, Edward L. Pierce of the Solvay companies; Charles Pierce of Boston, counsel for the New England Telephone Co., and George Pierce, a prominent Boston physician.

JAMES WILSON, who served as Secretary of Agriculture for fifteen years, died on Aug. 26 at Traer, Iowa, after an illness of many weeks.

Book Reviews

WATER POWERS OF BRITISH COLUMBIA. By *Arthur V. White*, assisted by *Charles J. Vick*. 644 pp. and maps, illus. Ottawa: Commission of Conservation.

This is part of an exhaustive study undertaken by the Commission of Conservation to prepare a complete inventory of the water-power resources of Canada. The work was begun in 1910 and has resulted in publication of volumes on Water Powers of Canada, Water Powers of Manitoba, Saskatchewan and Alberta and the current volume of Water Powers in British Columbia. The estimated total of horsepower in the latter province is 2,500,000. The commission calls attention to the fact, however, that the grand totals representing horsepower possibilities for large sections of a country are apt to be misleading. Furthermore in the development of water power it must be recognized that such interests as domestic and municipal water supply, agriculture, irrigation and navigation, fisheries, mining and riparian rights are dependent on the same source. The volume contains a chapter on water legislation in British Columbia and another on rules and regulations for the development of power. A separate chapter is devoted to the topography of power-site tables of the Columbia, Fraser and MacKenzie rivers, Vancouver Island and mainland Pacific coast. Other chapters are devoted to stream flow data, and another on meteorological data. The book will be of distinct value to companies contemplating the development of water power in Canada or to industries which require water power in their operations. H. C. PARMELEE.

Current Market Reports

The Iron and Steel Market

Pittsburgh, August 27, 1920.

In the past week or two the iron and steel market has exhibited itself as quite lacking in definite motive or substantial basis. Nearly everything that occurs has a distinct opportunist coloring. For illustration, pig-iron prices in most districts have been shoved upward, when prices were already too high for safety in proportion to steel prices. Those who were in the market as buyers were not particular as to prices, since they were buying only for urgent requirements of the present or near future. Again, the steel market cannot be regarded as really on a rational basis until the selling prices of the Steel Corporation and the independents are together, or at least not far apart, but the gap is not being bridged. That it is possible for the two sets of prices to exist side by side is due to the fact that the markets are entirely different in point of delivery, and the difference in time of delivery has been widening. At the beginning of the year, when the departure of the independent prices from the Steel Corporation prices became clearly marked, the corporation had 8,000,000 tons of unfilled business on books, while now it has 11,000,000 tons. The independents were then able to sell much more week by week than they were producing, whereas of late their sales have run well below their shipments. In other words, it requires a greater promptness of delivery, compared with a Steel Corporation delivery, to enable an independent to get the extra price.

Illustrative of the peculiar alignments in the market, the Industrial Board prices of March 21, 1919, may be taken as a basis. The prices in that schedule were fairly well proportioned. The Steel Corporation prices are Industrial Board prices exactly. Prices obtained lately by independent mills on steel products run about $20 a ton, or about 30 per cent, above the Industrial Board prices, while prices of pig iron with the latest advances average about 75 per cent above the Industrial Board figures. Before the event one could scarcely have conceived the possibility of such price relations existing even for a moment, let alone of their continuing with no signs of the law of supply and demand working toward a readjustment.

DULL MARKETS

Apart from the activity in pig iron, which has been in prices more than in tonnage turnover, since prices advanced on a relatively small amount of buying, the iron and steel markets generally have been very dull, and even more stagnant than they were earlier in this midsummer period. It seems to be clearly established now that the dullness is not associated closely with the season of the year but is a product of more fundamental conditions, including the state of business generally and the awkward position into which prices have worked themselves.

Such demand for steel as is exhibited is confined almost wholly to the deliveries that are very difficult to get. The independent sheet mills are sold through November and about 40 per cent into December, according to their computation, and there is insistent demand for sheets even for October and November delivery. Plates, on the other hand, can be obtained for delivery in a very few weeks and there is scarcely any demand for plates. One can buy plates at 3.25c., although some mills ask 3.50c. and higher. Early in the year plates commanded much higher prices than merchant bars, but now bars in the smaller sizes are "scarce" and there is ready sale at 3.50c., sometimes at still higher prices. Shapes can be had at 3.10c. and are entirely neglected.

The report for July of the Bridge Builders' and Structural Society shows bookings of fabricated steel contracts during the month at 50 per cent of the fabricating capacity,

this corresponding with the report for June. The continued dullness in this line is practically unprecedented.

Railroad demand has not developed in volume, and is hardly expected for some time to come. Car buying is almost entirely confined to industrial companies and thus does not run into volume. There is a fair running demand for steel for car repairs.

TRANSPORTATION IMPROVING

Transportation conditions continue to improve. Mills are now reducing their accumulated stocks of steel, produced aganist orders but held on account of car shortage, whereas until late in July there were almost constant additions to stocks. The movement, however, may be considered as one in quantity rather than in quality. The shipments that leave the mills are good, but on account of embargoes and other restrictive influences the distribution is poor, some consumers receiving very good shipments and others very light shipments.

It is a common view in iron and steel circles that the railroads are "set" for a great improvement in physical operations, now that Sept. 1 is so near at hand, this being the date upon which the railroads must begin making their revenue themselves. The Interstate Commerce Commission has ordered that sixty open-top cars be furnished daily to pipe mills in the Pittsburgh and Youngstown districts, for moving oil-country goods to the South and Southwest.

SEMI-FINISHED STEEL

In the East several thousand tons of standard billets have been sold on the basis of $60 Pittsburgh, a figure that was difficult for a buyer to get two or three weeks ago and was practically impossible a month ago. Several sales of sheet bars have been made at $67.50 Pittsburgh, when $75 was the market a few weeks ago. Semi-finished steel has been declining, while pig iron, metallurgically the raw material, has been advancing.

In nearly all districts pig-iron prices have been advancing, and sharply at that, though the sales are in thousands of tons when tens of thousands of tons have hitherto figured when prices were advancing. Small transactions in valley bessemer and basic, just running into four figures, have established those grades at $48.50 valley, or $1.50 advance in bessemer and $2 advance in basic, while foundry remains at $50 valley, to which it advanced recently by a $4 jump.

In the past few days slight signs have appeared perhaps portending a weakening in prices, or at any rate a refusal of consumers to follow the market. Southern iron in the past generally took the lead of pig iron in general in advances and declines, and it may be significant therefore that Southern iron did not advance in the past two or three weeks, when the valley, eastern Pennsylvania, Buffalo and other markets were advancing, while it is now said that there are more sellers of Southern iron at the $42 minimum, and fewer at premiums over this price, than ten days ago.

The Chemical and Allied Industrial Markets

New York, August 27, 1920.

There has been very little activity in the chemicals during the week—in fact, dealers and handlers report they have done nothing in the way of actual business. The *acid* branch is in about the same condition, suffering from lack of interest that has been apparent for some time. It is a peculiar fact that in spite of the present weakness prices are practically the same as in the last report, with the following exceptions noted:

	Today	Week Ago	Year Ago
Oxalic, crystals	$0.53 @0.57	$0.55@0.60	$0.25 @0.30
Lactic, 44 per cent....	0.10 @0.11	0.11@0.12	0.11 @0.14
Salammoniac, white...	0.15½@0.16½	0.16@0.16½	0.12½@0.13
Copperas	2.00 @2.50	2.50@3.00	1.00 @1.20
Potassium sulphate ...	2.40 @2.55	2.25@2.40	2.25

Methyl alcohol, to be listed hereafter as *methanol*, is nominally quoted $3.25@$3.30 for 95 per cent and $3.50@$3.55 per gal. for the pure grade. The Government restrictions placed on the sale of this article are so stringent that it has become very difficult for a small buyer to make a purchase, while *ethyl* alcohol because of scarcity is nominally quoted around $5.50@$5.75 per gal. In line with

these prices *formaldehyde* is still firm at 48c. in car lots and 50c. in less than car lots. The above figures are manufacturers' prices and have been in force for some time, but small quantities that have been on the market for some time can be obtained as low as 40c. per lb.

COAL-TAR PRODUCTS

Prices have been well sustained during the period despite the very inactive condition of the market. The present situation of the spot market is the antithesis of that prevailing a few months ago, when it was practically impossible to obtain any of the crudes or intermediates for prompt delivery. Now the spot demand is so small that business is at a standstill and wherever a likely purchaser is found generous concessions are made on the prevailing prices. Producers are progressing rapidly and most of them are in a fair way to catch up on back contracts which had to remain untouched under the pressure of recent conditions.

NAVAL STORES

An unusual condition exists in the *rosin* market inasmuch as the lowest grade, B, is selling 10c. higher than any of the other grades. Grades D to W are all quoted at $14.50, and this price, it is expected, will prevail for some time. This situation has been brought about by an excessively heavy demand for the lower grades from South America, where it is used in manufacturing soaps and varnishes. The domestic demand for the higher grades which are used for the same purpose has fallen off to such an extent that there is surplus on hand, thus lowering the price to the same level as the B-I grades. The supply in the local market is ample to meet the demand, which has been very light recently. *Turpentine* is also weaker, with a 5c. drop recorded from last week's $1.60 mark. This has been caused by two elements, the light buying interest and the uncertainty existing in the Savannah market. Buyers are holding back and are evidently expecting lower prices in this commodity.

OILS

This market is practically at a standstill, as buyers are either well taken care of or are holding out for still lower levels. Prices on the list are nominal, as concessions can be obtained on almost all of the quotations listed. *Linseed* has still further declined and current prices are: $1.43 in less than car lots; $1.37@$1.40 in car lots. Whatever buying that is being done is for actual requirements only, and on a spot basis. There has been very little interest manifested in futures, and this condition is expected to prevail for a few weeks more at least.

The Chicago Market

Chicago, August 25, 1920.

The situation in the local market is no different from that in the rest of the country in that the entire trade—buyers, dealers and manufacturers—is engaged in watchful waiting. A feeling of uncertainty as to the future trend of prices is acting as a stop on trading, and this cessation of business in itself gives the market a weak tendency, as all holders of stock, particularly re-sellers, are desirous of moving goods.

This uncertain feeling is most pronounced in regard to vegetable oils. Enormous imports of flaxseed from the Argentine, coupled with a large crop in Canada and the Northwest, tends to make the future of linseed oil a little dubious. A heavy cotton crop coming up and an immense carry-over of cottonseed oil from last year combine to make present prices look too high, and Oriental financial troubles make anything possible in the copra and coconut oil trade. Other oils, in sympathy, are correspondingly weak and uncertain.

Among the heavy chemicals, the *alkalis*, former leaders in high prices, are at a standstill, traders and buyers alike apparently awaiting the issuance of 1921 quotations by makers. Chemical manufacturers in general claim to look for higher prices, while buyers are equally strong in the opinion that the peak has already been passed. This

renders the one not anxious to sell and the other unwilling to buy, hence the stagnant market.

In the main, railroad service is good, though some complaint is heard from the fertilizer and acid people. Imposition of the new tariffs will undoubtedly have some effect on prices, although the extent will remain unknown until the manufacturers and dealers have had time to study the rates.

HEAVY CHEMICALS

The *alcohols* remain unchanged during the past month. *Ethyl* grade, at $5.52½ in five barrel lots, $5.57½ in single barrels, is firmly held, and but little is changing hands. *Methanol* (methyl alcohol), 95 per cent, is quoted at $3.35@$3.65 per gal., but this quotation means little, as it is practically unobtainable. *Denatured* is a little freer in movement at $1.09 per gal. *Formaldehyde* has reflected recent fluctuation in the Eastern market by a decline last week to 51c. followed by a stronger market this week, today's price being 53c. This is a net decline of 2c. since the first of the month, and in view of the relatively high price and the scarcity of *methyl alcohol* a recovery is not improbable.

Copper sulphate continues to show good business at 9c. per lb. in car lots. Should export demand increase, higher prices can be expected. *Copper carbonate* is firm at 27c., solely on account of cost of production, as demand is very light. *Copperas* is offered at $2.35 per cwt., f.o.b. works, with no takers, and spots are quoted at $2.75, with considerable shading being necessary to induce business. *Arsenic* is uncertain in price, tending to lower levels. Current transactions in *white arsenic* are reported at about 15c. per lb. and red is going at 19@20c. Supply is quite free and futures can be engaged at 1@2c. lower on both kinds.

Bleaching powder, still hard to get, is alone among the alkalis in holding firm. It is quoted today at around 7c. per lb., being available in extremely limited quantities only. *Soda ash*, selling weakly on the spot at $3.15@$3.25 per cwt., is still quoted by makers at $3.35. Not much business is being closed at that figure. *Caustic soda* is in good supply and the price continues weak at 5½c. per lb. or less. Much interest is noted in the price to be set by producers on 1921 goods. Not much free *sal soda* is in the market and current quotations are fairly firm at 2c. per lb.

A little better market is noted the last few days in the *acids*, but prices in general are weak and subject to shading. Definite quotations are hard to get. *Acetic acid*, 28 per cent, commercial, is bringing $3.65@$3.75 per cwt., export *carbolic* is quoted all the way from 12@15c. and *sulphuric*, 66 degree, is still quoted at $22 per ton.

COAL-TAR PRODUCTS

Very slow market continues the rule in Chicago with no sensational price changes. The apparent approaching end of the Russo-Polish war has a weakening tendency which, in the face of prevailing high prices, discourages any active trading. *Benzol* is quoted at 38c. per gal. for spot deliveries, but some shading is in evidence. *Cresol*, held strongly at 18½@19c., is not very plentiful and *toluol* is equally firm at 37c., though but little actual movement is noted in any of these crudes. *Aniline oil* is off for sales from local stock, sales as low as 30c. per lb. being recorded and future offers being made at 28c. Light demand is making holders of second hands willing to shade prices. The same is true of *aniline salt*, which is quoted down to 38c. this week. *Benzoic acid* is in good demand at 90c. per lb. for U. S. P., and *benzaldehyde* is correspondingly strong at 68c. per lb. for the technical, $2.30@$2.50 for F.F.C.

NAVAL STORES

The market in general is a little slower, although local dealers are still disposing of goods as rapidly as they are received. Rail conditions are no longer a problem, shipments moving easily. Current quotation on *turpentine* is $1.62@$1.63 per gal., 13c. less than at the first of the month, while *pine oil*, both pure and destructively distilled, remains firm at $1.90. *Rosin* is off a shade on all grades, current transactions ranging from $15.75@$16 in less than car lots.

VEGETABLE OILS

Holders of stock are facing heavy shrinkages in value, as prices continue to decline with still no buyers to take advantage of them. *Linseed oil* quotations cover a wide range, $1.40 per gal. apparently being as close a quotation as is obtainable. *Red oil*, with the disappearance of consumers from the market, finds no buyers at 12c. and *cottonseed oil*, facing an enormous production this fall, is down to 16c. or even less for refined and deodorized. Orientals are holding slightly more firm, *soya bean oil* being quoted at 9½c., seller's tanks, f.o.b. coast and *coconut oil* at 13c. On the latter product, local price is firm at 17¼c. for spots.

The Baltimore Market

Baltimore, Md., August 26, 1920.

During the past two weeks there have been a number of developments which have tended to depress the fertilizer market. Farm products for the first time in a number of years have been selling at or below cost of production, resulting in some of the farmers deciding not to harvest certain crops. This will in turn seriously affect payment of fertilizer bills, and practically the entire trade has decided in view of unsettled conditions to defer future purchases of materials, awaiting further developments.

On account of the heavy crop of cotton seed and lack of demand from either fertilizer or feed manufacturers, the market on *cottonseed meal* has further declined, and no immediate relief seems to be in sight. The prospects of finding an outlet for export are not very encouraging, first, on account of the present foreign exchange situation, and secondly, because European vegetable meals are obtainable there on a lower basis than prevailing prices in this country. Prime *cottonseed meal* is now obtainable for September-December shipment as low as $7.75 per unit based on the increased freight rates, which amount to about 50c. per unit. This difference, therefore, about represents the decline in the market during the past two weeks.

ACID PHOSPHATE

No important changes have taken place in this article, and it is one of the few materials that is not affected by the present depression, on account of the well sold up condition of the market, and many of the dry mixers still have to cover for their requirements. It is anticipated that the market on *acid phosphate* will remain stationary, at least for the immediate future, and October-December is still nominally quoted at $19@$20 per ton, in bulk, basis 16 per cent.

TANKAGE

Prices on this commodity are ruling easier, and it is now possible to secure Eastern ground tankage at about $7.60@$7.75 and 10c. c.a.f. Baltimore, which price, however, is lower than the Western product can be delivered here. *Foreign nitrogenous material*, however, is obtainable at $7.25 per unit of ammonia delivered Baltimore, with no buying interest being manifested.

NITRATE OF SODA

The market is easy and September-October deliveries are nominally quoted at $3.65@$3.70, November-December $3.75@$3.80, and January-April $3.90@$3.95. It is reported that the present favorable low rates of sterling exchange are responsible for the decreased prices.

POTASH

Practically the entire trade is playing the waiting game, and it is expected that this will have the desired effect in the near future. There is practically no demand for spot deliveries, and August-September arrivals of *muriate* are quoted at $2.40, *manure salt* at $1.95 and *kainit* at $2.05, without any important sales.

FISH SCRAP

None of this material is at present pressing on the market either from producers or second hands, and the market remains at $7.50 and 10c. for dry *unground scrap* f.o.b. fish factories.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots		Less Carlots	
Acetic anhydride	lb.			$0.65 –	$0.75
Acetone	lb.	$0.15 –	$0.20	.21 –	.22
Acid, acetic, 28 per cent	cwt.	3.50 –	3.75	4.00 –	4.50
Acetic, 56 per cent	cwt.	6.50 –	7.50	8.50 –	9.50
Acetic, glacial, 99½ per cent	arbuv cwt.	14.00 –	16.00	16.25 –	
Boric, crystals	lb.	.15 –	.16	.16½ –	.19
Boric, powder	lb.	.15½ –	.16½	.17 –	.20
Citric	lb.	.78 –	.80	.82 –	.84
Hydrochloric (nominal)	cwt.	2.25 –	3.00	3.10 –	4.00
Hydrofluoric, 52 per cent	lb.	.13½ –	.14	.14½ –	.15½
Lactic, 44 per cent tech	lb.	.10 –	.11½	.12 –	.16
Lactic, 22 per cent tech	lb.	.04½ –	.05½	.06 –	.07
Molybdic, C. P.	lb.	4.00 –	4.50	4.50 –	5.00
Muriatic, 20 deg. (see hydrochloric)					
Nitric, 40 deg	lb.	.06 –	.07	.07½ –	.08½
Nitric, 42 deg	lb.	.07½ –	.08	.08½ –	.09½
Oxalic, crystals	lb.	.53 –	.54	.55 –	.57
Phosphoric, Ortho, 50 per cent solution	lb.	.18 –	.23	.24 –	.25
Pieric	lb.	.28 –	.35	.40 –	.50
Pyrogallic, resublimed	lb.	2.3 –	2.55	2.60 –	2.65
Sulphuric, 60 deg., tank cars	ton	12.00 –	16.00		
Sulphuric, 60 deg., drums	ton				
Sulphuric, 66 deg., tank cars	ton	16.00 –	17.00	18.00 –	20.00
Sulphuric, 66 deg., drums	ton	26.00 –	28.00		
Sulphuric, 66 deg., carboys	ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 –	30.00	37.00 –	42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 –	30.00	38.00 –	42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 –	35.00	43.00 –	
Tannic, U. S. P.	lb.	1.45 –	1.50	1.55 –	1.65
Tannic (tech.)	lb.	.60 –	.70	.80 –	.90
Tartaric, crystals	lb.			.74 –	.77
Tungstic, per lb. of WO₃	lb.			1.20 –	1.40
Alcohol, Ethyl (nominal)	gal.	5.50 –	5.75	6.00 –	7.00
Alcohol, Methyl (see methanol)					
Alcohol, denatured, 188 proof (nominal)	gal.			1.10 –	1.15
Alcohol, denatured, 190 proof (nominal)	gal.			1.05 –	1.10
Alum, ammonia lump	lb.	.05 –	.05½	.05½ –	.06
Alum, potash lump	lb.	.08 –	.08½	.09 –	.09½
Alum, chrome lump	lb.		.17	.18 –	.19
Aluminum sulphate, commercial	lb.	.04½ –			
Aluminum sulphate, iron free	lb.	.06 –			
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ –	.10½	.11 –	.12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 –	.35½	.36 –	.37
Ammonium carbonate, powder	lb.	.16 –	.16½	.17 –	.18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ –	.16½	.17 –	.18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 –	.13½	.13½ –	.14½
Ammonium nitrate	lb.	.09 –	.10	.11 –	.14
Ammonium sulphate	lb.	.07 –	.07½	.08½ –	
Amylacetate	gal.			5.00 –	
Amylacetate tech	gal.			4.75 –	5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.14 –	.16	.16½ –	.17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 –	.21	.22 –	.25
Barium chloride	ton	150.00 –	160.00		
Barium dioxide (peroxide)	lb.	.21 –	.23	.24 –	.25
Barium nitrate	lb.	.10 –	.12	.12½ –	.13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ –	.05	.05½ –	.06
Bleaching powder (see calcium hypochlorite)					
Blue vitriol (see copper sulphate)					
Borax (see sodium borate)					
Brimstone (see sulphur, roll)					
Bromine	lb.	.70 –	.90	1.00 –	1.05
Calcium acetate	cwt.	3.50 –	3.55		
Calcium carbide	lb.	.04½ –	.04½	.04½ –	.05½
Calcium chloride, fused, lump	ton	33.00 –	34.00	35.00 –	45.00
Calcium chloride, granulated	lb.	.02 –	.02½	.03 –	.03½
Calcium hypochlorite (bleaching powder)	cwt.	6.50 –	7.50	8.00 –	8.50
Calcium peroxide	lb.			1.50 –	1.70
Calcium phosphate, monobasic	lb.			.75 –	.80
Calcium sulphate, pure	lb.			.25 –	.30
Carbon bisulphide	lb.	.08 –	.09	.10 –	.11
Carbon tetrachloride, drums	lb.	.14 –	.15	.16 –	.17
Carbonyl chloride (phosgene)	lb.			.80 –	1.05
Caustic potash (see potassium hydroxide)					
Caustic soda (see sodium hydroxide)					
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 –	.09½	.10 –	.10½
Chloroform	lb.	.40 –	.43	.44 –	.47
Cobalt oxide	lb.			2.00 –	2.05
Copperas (see iron sulphate)					
Copper carbonate, green precipitate	lb.	.27 –	.28	.29 –	.31
Copper cyanide	lb.			.65 –	.70
Copper sulphate, crystals	lb.	.08 –	.09	.09 –	.09½
Cream of tartar (see potassium bitartrate)					
Epsom salt (see magnesium sulphate)					
Ethyl Acetate Com, 85%	gal.	1.10 –	1.30	1.40 –	
Ethyl Acetate pure (acetic ether 98% to 100%)				1.75 –	
Formaldehyde, 40 per cent (nominal)	lb.	.48 –	.50		
Fusel oil, ref	gal.			5.25 –	6.00
Fusel oil, crude (nominal)	gal.				
Glauber's salt (see sodium sulphate)					
Glycerine, C. P. drums extra	lb.			.26½ –	.28½
Iodine, resublimed	lb.	4.30 –	4.35	4.40 –	4.45
Iron oxide, red	lb.			.03 –	.20
Iron sulphate (copperas)	cwt.	2.00 –	2.25	2.35 –	2.75
Lead acetate, normal	lb.			.13½ –	.16
Lead arsenate (paste)	lb.	.11 –	.12	.13 –	.17
Lead nitrate, crystals	lb.			.90 –	1.00
Litharge	lb.	.14 –	.15	.15½ –	.16
Lithium carbonate	lb.			1.50 –	
Magnesium carbonate, technical	lb.	.12½ –	.13½	.15 –	.16
Magnesium sulphate, U. S. P.	100 lb.	3.50 –	3.90	4.00 –	4.50
Magnesium sulphate, commercial	100 lb.			3.5½ –	3.60
Methanol, 95%	gal.			3.25 –	3.30
Methanol, pure	gal.			3.5½ –	3.55
Nickel salt, double	lb.			.14 –	.16
Nickel salt, single	lb.			.13 –	.14
Phosgene (see carbonyl chloride)					
Phosphorus, red	lb.	.50 –	.55	.60 –	.65
Phosphorus, yellow	lb.			.35 –	.37
Potassium bichromate	lb.	.36 –	.38	.39 –	.40

		Carlots		Less Carlots	
Potassium bitartrate (cream of Tartar)	lb.	$0.52	$0.56	$0.57	$0.58
Potassium bromide, granular	lb.			.70	.73
Potassium carbonate, U. S. P.	lb.	.50	.55	.56	.60
Potassium carbonate, crude	lb.	.20	.25	.26	.28
Potassium chlorate, crystals	lb.	.16	.17½	.18	.20
Potassium hydroxide (caustic potash)	lb.	.77	.28	.29	.33
Potassium iodide	lb.			3.35	3.60
Potassium nitrate	lb.	.17	.17½	.19	.21
Potassium permanganate	lb.	.75	.80	.85	.95
Potassium prussiate, red	lb.	.90	1.00	1.05	
Potassium prussiate, yellow	lb.	.32	.36	.35	.40
Potassium sulphate (powdered)	ton	$240.00	255.00		
Rochelle salts (see sodium potas. tartrate)					
Salammoniac (see ammonium chloride)					
Sal soda (see sodium carbonate)					
Salt cake	ton			40.00	50.00
Silver cyanide (nominal)	oz.			1.25	
Silver nitrate (nominal)	oz.			.60	.62
Soda ash, light	100 lb.			3.20	3.50
Soda ash, dense	100 lb.			3.55	3.65
Sodium acetate	lb.	.10	.15	.20	.25
Sodium bicarbonate	100 lb.	2.50	2.75	3.00	3.50
Sodium bichromate	lb.	.22	.24	.26	.27
Sodium bisulphate (nitre cake)	ton	7.00	8.00	9.00	11.00
Sodium bisulphite Powdered, U.S.P.	lb.	.08½		.10	.11
Sodium borate (borax)	lb.	.09	.10	.11	.12
Sodium carbonate (sal soda)	100 lb.	2.00	2.10	2.15	2.25
Sodium chlorate	lb.	.11	.12	.12½	.14
Sodium cyanide, 96-98 per cent.	lb.	.25	.30	.32	.35
Sodium fluoride	lb.	.18		.19	.20
Sodium hydroxide (caustic soda)	100 lb.	5.60	5.70	5.75	6.00
Sodium hyposulphite	lb.			.03	.04
Sodium molybdate	lb.	2.50		3.25½	
Sodium nitrate	100 lb.	3.00	3.25	3.75	4.00
Sodium nitrite	lb.	.16	.18	.19	.20
Sodium peroxide, powdered	lb.	.32	.35	.35	.40
Sodium phosphate, dibasic	lb.	.03½	.04½	.04½	.05
Sodium potassium tartrate (Rochelle salts)	lb.			.39	.40
Sodium prussiate, yellow	lb.	.23	.27	.31	.32
Sodium silicate, solution (40 deg.)	lb.	.01½	.01½	.02	.02½
Sodium silicate, solution (60 deg.)	lb.	.02½	.03	.04	.05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60	1.70	1.75	2.50
Sodium sulphide, crystal, 60-62 percent (conc)	lb.	.09½	.10	.10½	.11
Sodium sulphite, crystals	lb.	.04	0.4½	.04½	.05
Strontium nitrate, powdered	lb.	.15	.18½	.19	.20
Sulphur chloride red	lb.	.08	.09	.10	.10½
Sulphur, crude	ton	16.00	20.00		
Sulphur dioxide, liquid, cylinders	lb.	.09		.10	.12
Sulphur (sublimed), flour	100 lb.			3.80	4.35
Sulphur, roll (brimstone)	100 lb.			3.40	3.90
Tin bichloride (stannous)	lb.	.42½	.44	.45	.46
Tin oxide	lb.			.55	.65
Zinc carbonate, precipitate	lb.	.16	.18	.19	.20
Zinc chloride, gran.	lb.	.13	.13½	.13½	.17
Zinc cyanide	lb.	.45	.49	.50	.60
Zinc dust	lb.	.11	.12	.12	.13
Zinc oxide, U. S. P.	lb.	.17	.25		
Zinc sulphate	lb.	.03½	.03½	.04	.06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40	—	$1.50	
Alpha naphthol, refined	lb.	1.60	—	1.70	
Alpha naphthylamine	lb.	.50	—	.52	
Aniline oil, drums extra	lb.	.30	—	.33	
Aniline salts	lb.	.35	—	.40	
Anthracine, 80% in drums (100 lb.)	lb.	.90	—	1.00	
Benzaldehyde (f.f.c.)	lb.	2.00	—	2.10	
Benzidine, base	lb.	1.35	—	1.40	
Benzidine, sulphate	lb.	1.15	—	1.25	
Benzoic acid, U.S.P.	lb.	.85	—	.90	
Benzoate of soda, U.S.P.	lb.	.80	—	.90	
Benzol, pure, water-white, in drums (100 gal)	gal.	.38	—	.40½	
Benzol, 90%, in drums (100 gal)	gal.	.36½	—	.38½	
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40	
Benzyl chloride, tech.	lb.	.25	—	.35	
Beta naphthol benzoate (nominal)	lb.	3.50	—	4.00	
Beta naphthol, sublimed (nominal)	lb.		—		
Beta naphthol, tech (nominal)	lb.	.85	—	.95	
Beta naphthylamine, sublimed	lb.	2.25	—	2.40	
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.19	
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25	
Cresylic acid, 97-99%, straw color, in drums	gal.	1.15	—	1.20	
Cresylic acid, 95-97%, dark, in drums	gal.	1.05	—	1.10	
Cresylic acid, 50%, first quality, drums	gal.	.65	—	.75	
Dichlorbenzol	lb.	.08	—	.10	
Diethylaniline	lb.	1.50	—	1.60	
Dimethylaniline	lb.	1.00	—	1.05	
Dinitrobenzol	lb.	.30	—	.37	
Dinitro-chlorbenzol	lb.	.32	—	.35	
Dinitronaphthaline	lb.	.45	—	.55	
Dinitrophenol	lb.	.40	—	.45	
Dinitrotoluol	lb.		—	.40	
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.40	
Diphenylamine (nominal)	lb.	.80	—	.85	
H-acid (nominal)	lb.	2.00	—	2.25	
Metaphenylenediamine	lb.	1.25	—	1.30	
Monochlorbenzol	lb.	.18	—	.20	
Monoethyl aniline	lb.	2.00	—	2.40	
Naphthaline crushed, in bbls. (250 lb.)	lb.		—	.19	
Naphthaline, flake	lb.		—	.19	
Naphthaline, balls	lb.		—	.85	
Naphthionic acid, crude	lb.	.75	—	.85	
Nitrobenzol	lb.	.14	—	.19	
Nitro-naphthaline	lb.	.40	—	.50	
Nitro-toluol	lb.	.18	—	.25	
Ortho-amidophenol	lb.	3.25	—	4.25	
Ortho-dichlor-benzol	lb.	.15	—	.20	
Ortho-nitro-phenol	lb.	.80	—	.85	
Ortho-nitro-toluol	lb.	.25	—	.40	
Ortho-toluidine	lb.	.30	—	.35	
Para-amidophenol, base	lb.	2.50	—	3.00	
Para-amidophenol, HCl	lb.	2.50	—	3.00	
Para-dichlor-benzol	lb.	.08	—	.12	
Paranitraniline	lb.	1.10	—	1.20	

Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.50	—	2.65
Paratoluidine	lb.	2.00	—	2.25
Phthalic anhydride	lb.	.60	—	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.20
Pyridin	gal.	2.00	—	3.50
Resorcin, technical	lb.	4.25	—	4.5
Resorcin, pure	lb.	6.25	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	—	.52
Salicylic acid, U. S. P.	lb.	.50	—	.61
Salol	lb.	.90	—	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33	—	.35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.35	—	
Toluol, in drums	gal.	.38½	—	.40½
Xylidine, drums, 100 gal.	lb.	.50	—	.65
Xylol, pure, in drums	gal.	.47½	—	.50½
Xylol, pure, in tank cars	gal.	.45	—	
Xylol, commercial, in drums, 100 gal.	gal.	.32½	—	.35½
Xylol, commercial in tank cars	gal.	.30	—	

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	—	$0.39
Beeswax, refined, light	lb.	.37	—	.38
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1. (nominal)	lb.	.90	—	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.85
Carnauba, No. 3, North Country	lb.	.35	—	.36
Japan	lb.	.17	—	.18
Montan, crude	lb.	.25	—	.26
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½	—	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 125 m.p	lb.	.12½	—	
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	—	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	—	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	—	.18½
Stearic acid, single pressed	lb.	.20	—	.21
Stearic acid, double pressed	lb.	.22	—	.23
Stearic acid, triple pressed	lb.	.24	—	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.946	gal.	$2.15
Pine oil, pure, dest. dist	gal.	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$14.60	—	
Rosin E-I.	280 lb.	14.50	—	
Rosin K-N.	280 lb.	14.50	—	
Rosin W. G.-W. W.	280 lb.	14.50	—	
Wood rosin, bbl.	280 lb.	15.00	—	
Spirits of turpentine	gal.	1.55	—	
Wood turpentine, steam dist.	gal.		—	
Wood turpentine, dest. dist.	gal.		—	
Pine tar pitch, bbl.	200 lb.		—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.72	—	
Rosin oil, second run	gal.	.75	—	
Rosin oil, third run	gal.	.92	—	

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.29	—	$0.31
Upriver coarse	lb.	.19	—	.20
Upriver caucho ball	lb.	.20	—	.22
Plantation—First latex crepe	lb.	.30	—	
Ribbed smoked sheets	lb.	.28	—	
Brown crepe, thin, clean	lb.	.26	—	
Amber crepe No. 1	lb.	.28	—	

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.16½	—	$0.18
Castor oil, AA, in bbls.	lb.	.19	—	
China wood oil, in bbls.	lb.	.17½	—	.18
Cocoanut oil, Ceylon grade, in bbls.	lb.	.15	—	.16
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.16½	—	.16½
Corn oil, crude, in bbls.	lb.	.14½	—	.15½
Cottonseed oil, crude (f.o.b. mill)	lb.	.10	—	.11
Cottonseed oil, summer yellow	lb.	.12½	—	.13½
Cotonseed oil, winter yellow	lb.	.17½	—	.18½
Linseed oil, raw, car lots (domestic)	gal.	1.40	—	1.43
Linseed oil, raw, tank cars (domestic)	gal.	1.37	—	1.40
Linseed oil, boiled, car lots (domestic)	gal.	1.43	—	1.50

Olive oil, commercial	gal.	3.00	—	3.10
Palm, Lagos	lb.	.10½	—	
Palm, bright red	lb.	.10½	—	
Palm, Niger	lb.	.11	—	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½	—	.12½
Peanut oil, refined, in bbls	lb.	.17	—	.18
Rapeseed oil, refined in bbls	gal.	1.40	—	1.50
Rapeseed oil, blown, in bbls	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls. N.Y.	lb.	.14	—	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½	—	.11

FISH

Winter pressed Menhaden	gal.	$0.90	—	$1.05
Yellow bleached Menhaden	gal.	0.95	—	1.05
White bleached Menhaden	gal.	1.00	—	1.25
Blown Menhaden	gal.	1.00	—	1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	—	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00	—	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00	—	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00	—	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00	—	19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00	—	
Barytes, floated, f.o.b. St. Louis	net ton	26.50	—	28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00	—	11.25
Blanc fixe, dry	lb.	.05½	—	.06
Blanc fixe, pulp	net ton	60.00	—	80.00½
Casein	lb.	.15	—	.18
Chalk, domestic, extra light	lb.	.05	—	.06
Chalk, domestic, light	lb.	.04½	—	.05½
Chalk, domestic, heavy	lb.	.04	—	.05
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.05	—	.06
Chalk, English, dense	lb.	.04½	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00	—	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	net ton	30.00	—	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50	—	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	20.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	20.00
Feldspar, ground, f.o.b. Baltimore	net ton	30.00	—	
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00	—	
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	—	
Fuller's earth, imported, powdered	net ton	35.00	—	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.		—	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.		—	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.		—	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.		—	.10
Graphite, crucible, 85% carbon	lb.		—	.08
Graphite, crucible, 88% carbon	lb.		—	.09½
Graphite, crucible, 90% carbon	lb.		—	.10½
Pumice stone, imported, lump	lb.	.04	—	.50
Pumice stone, domestic, lump	lb.	.06	—	
Pumice stone, ground	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton		—	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton		—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	1.35	—	1.40
Shellac, orange superfine	lb.	1.40	—	1.45
Shellac, A. C. garnet	lb.	1.10	—	1.15
Shellac, T. N.	lb.	1.15	—	1.20
Soapstone	ton	15.00	—	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	10.00	—	20.00
Talc, roofing grades, f.o.b. Vermont	ton	9.00	—	15.00
Talc, rubber grades, f.o.b. Vermont	ton	10.00	—	15.00
Talc, powdered, Southern, f.o.b. cars	ton	20.00	—	25.00
Talc, imported	ton	60.00	—	70.00
Talc, California Talcum Powder grade	ton	20.00	—	35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90–	100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	90–	95
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	50–	55
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45–	
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75–	
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45	55
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	100	110
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras	
Magnesite brick, f.o.b. Chester	net ton	90–	100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	55–	
Silica brick, f.o.b. Birmingham	1,000	51–	55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	55–	60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18	—	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20	—	.21
Ferro-manganese, 76-80% Mn, domestic	gross ton	135.00	—	225.00
Ferro-manganese, 76-80% Mn, English	gross ton	190.00	—	200.00
Spiegeleisen, 18-22% Mn	gross ton	75.00	—	
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.25	—	2.75
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.10	—	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	—	
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50	—	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe₂O₃, up to 20 % silica, not more than H 4% moisture	gross ton	$10.00	—	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr₂O₃	unit	.60		.65
Chrome ore, 40%, min., Cr₂O₃ f.o.b. Atlantic Seaboard	unit	.77	—	.85
*Coke, foundry, f.o.b. ovens	net ton	20.00	—	
*Coke, furnace, f.o.b. ovens	net ton	18.00	—	20.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00		
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	—	
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	25.00	—	27.50
Ilmenite, 52% TiO₂, per lb. ore	lb.	.01½	—	85.02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.70	—	.80
Manganese ore, chemical (MnO₂)	gross ton	75.00	—	.00
Molybdenite, 85% MoS₂, per lb. of MoS₂, N. Y.	lb.	.75	—	.85
Monazite, per unit of ThO₂	unit	42.00	—	
Pyrites, Spanish, fines ,c.i.f., Atlantic seaport	unit	.12	—	
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½	—	
Pyrites, Spanish, run of mines, ci.f., Atlantic seaport	unit	.12	—	.14
Pyrites, domestic, fines	unit	.12	—	.14
Rutile, 95% TiO₂ per lb. ore	lb.	.15	—	
Tungsten, Scheelite, 60% WO₃ and over, per unit of WO₃	unit	7.00	—	
Tungsten, Wolframite, 60% WO₃ and over, per unit of WO₃, N. Y. C	unit	6.00	—	7.00
Uranium Ore (Carnotite) per lb. of U₃O₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U₃O₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V₂O₅ contained	lb.	1.25	—	
Zircon, washed, iron free	lb.	.10	—	

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and Japanese	7.50
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	48.50
Lead, New York, spot	9.50
Lead, E. St. Louis, spot	8.90
Zinc, spot, New York	8.35
Zinc, spot, E. St. Louis	7.90@8.40

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	115.00@120.00
Iridium	oz.	350.00
Palladium	oz.	100.00@110.00
Mercury	75 lb.	83.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp.	14.50@15.00
Copper, heavy and wire	15.25@15.75
Copper, light and bottoms	13.00
Copper, heavy cut and crucible	16.25
Brass, heavy	10.25
Brass, light	7.75@8.00
No. 1 clean brass turnings	9.00@9.50
No. 1 comp. turnings	12.50@13.50
Lead, tea	4.75@5.00
Lead, heavy	7.25@7.50
Zinc, scrap	5.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.47	$3.97	$3.47	$5.00	$3.37	$3.97	$3.47
Soft steel bars	4.47	4.12	3.37	4.50	3.27	3.87	3.37
Soft steel bar shapes	4.47	4.12	3.37		3.27	3.87	3.37
Soft steel bands	6.32	5.32	4.07	6.25			
Plates, ¼ to 1 in. thick	4.67	4.17	3.67	4.50	3.57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

MARTINEZ—The Petroleum Products Co., San Francisco, is building a lubricating oil refinery near here. Estimated cost, $100,000.

Colorado

DENVER—The Federal Glass Co., c/o Sylvester & Co., First Natl. Bank Bldg., recently incorporated, plans to build a plant, including office bldg., circular glass house, factory and gas plant. Estimated cost, $250,000.

HAXTON—The city council will soon award the contract for the construction of a sanitary sewer system, including a septic tank. Estimated cost, $65,000. Royal D. Salisbury, 1415 E. Colfax Ave., Denver, engr.

ROCKY FORD—The American Beet Sugar Co. plans to build a 3-story building. Laboratory equipment will be installed in same. Estimated cost, $50,000.

YUMA—The city council will soon award the contract for the construction of a sanitary sewerage system, including a septic tank. Estimated cost, $80,000. Royal D. Salisbury, 1415 E. Colfax Ave., Denver, engr.

Connecticut

NEW HAVEN—Yale University is having sketches prepared for the construction of a 2-story chemical laboratory. Estimated cost, $250,000. Delano & Aldrich, 126 East 38th St., New York City, archts.

PORTLAND—The Portland Foundry Co., Freestone St., has awarded the contract for the construction of a 2-story 40x50-ft. foundry addition to Thos. Sellew. Estimated cost, $50,000.

Illinois

MARVA—The city plans to construct a sewage disposal plant. Estimated cost, $83,000. Miller, Holbrook & Waner, Milliken Bldg., Decatur, engrs.

Indiana

ONWARD—The Bd. of Educ. has awarded the contract for the construction of a 2-story, 80x125-ft. high school to S. I. Barnes, Logansport, $95,000. A chemical laboratory will be installed in same.

Maryland

BALTIMORE—The Amer. Can Co., 120 Bway., New York City, is having plans prepared for the construction of a factory. Estimated cost, $500,000.

BALTIMORE—The Coca-Cola Co. Pratt St. and Market Pl., has awarded the contract for the construction of a 4-story 196 x534-ft. factory and cooperage plant on Fort Ave. to the Arthur Tufts Co., Candler Annex, Atlanta, Ga. Estimated cost, $1,250,000.

CURTIS BAY (Baltimore P. O.)—The Union Acids Works plan to extend their plant. A 250x520-ft. site has been purchased on Aspen St. near Curtis Ave.

Massachusetts

BROCKTON—The city plans to build filtration bed. Estimated cost, $150,000.

Michigan

DETROIT—The Detroit Lacer Co., 27 A St., has awarded the contract for the construction of a 1-story, 80x100-ft. heat-treating building on A St. to the Scotten & Katz Building Co. Estimated cost, $35,000. Noted May 4.

GRAND RAPIDS—The city is having plans prepared for the construction of an additional waterworks system, including an addition to the filtration plant, etc. C. A. Paige, City Hall, engr.

WEST DETROIT (Detroit P. O.)—Varney & Varney, archts., Washington Blvd., Detroit, plan to build a 1-story, 70x90-ft. foundry. Estimated cost, $20,000. Owner's name withheld.

Minnesota

BERMIDJI—The Bd. of Educ. plans to build a 3-story high school. Chemical laboratory will be installed in same. Estimated cost, $500,000.

EVELETH—The city plans to install a filter plant. Estimated cost, $50,000.

WABASSO—G. A. Goblirsch, village clk., will receive bids until Sept. 9 for the construction of a sewage treatment plant and disposal plant. Estimated cost, $45,000. John F. Druar, 512 Globe Bldg., St. Paul, engr.

Missouri

ST. LOUIS—The city is having plans prepared for the construction of a morgue. Chemical laboratory and operating rooms will be installed. Estimated cost, $68,000. L. R. Bowen, City Hall, archt. and engr.

ST. LOUIS—The Sisters of Charity, 3539 Pine Blvd., are having preliminary plans prepared for the construction of a hospital on Pine St. Chemical laboratory will be installed in same. Estimated cost, $2,000,000. Lee & Rush, Syndicate Trust Bldg., archts.

ST. LOUIS—The Temtor Corn and Fruit Products Co. is constructing a building on Michigan Ave. and Davis St. Estimated cost, $200,000.

New York

BROOKLYN—Henry Holder, 242 Franklin Ave., will soon award the contract for the construction of a 1-story, 100x250-ft. foundry on Columbia St., for J. Riley. Estimated cost, $250,000.

Ohio

AKRON—The city has awarded the contract for the construction of 10 filtration beds, capacity 20,000,000 gal., to the Garrett Constr. Co., Kent. Estimated cost, $313,624.

BEDFORD—The David Round & Son Co. has awarded the contract for the construction of a 1-story 90x120-ft. foundry addition to the Du Perow Const. Co., Plymouth Bldg., Cleveland. Estimated cost, $50,000.

CINCINNATI — Rendigs, Panzer and Martin, archts., Palace Theatre Bldg., will receive bids about Sept. 15 for the construction of a 1-story pottery to have 45,000 sq.ft. of floor space on Lester Rd. for the Wheatley Pottery Co., Reading Rd.

CLEVELAND—The Rickersberg Brass Co., 3612 Perkins Ave., is building a 1-story 11x24-ft. foundry addition. Estimated cost, $5,000.

CLEVELAND—Western Reserve University, c/o E. Spease, Dean, plans to build a 3-story pharmacy building on Adelbert Rd. and Euclid Ave. Estimated cost, $200,000.

PAINESVILLE—The Light Alloys Co. has awarded the contract for the construction of a 1-story 75x140 ft. factory to the H. K. Ferguson Co., 6532 Euclid Ave., Cleveland. Estimated cost, $65,000.

Oklahoma

FAIRFAX—The city plans to construct sewage disposal plant and waterworks extensions. Estimated cost, $80,000. V. V. Long & Co., 1300 Concord Bldg., Okla. City, consult. engrs.

HENRYETTA—The Cogswell Refining Co. is having plans prepared for the construction of a petroleum refinery, having a capacity of 2,000 bbls. Estimated cost, $25,000. J. C. Bertsch, Tulsa, engr.

Pennsylvania

NEW CASTLE—The Lehigh Portland Cement Co., 718 Hamilton St., Allentown, had plans prepared for the construction of a plant. Estimated cost, $200,000.

PHILADELPHIA — The Hellwig Silk Dyeing Co., 9th and Buttonwood Sts., has awarded the contract for the construction of a 2-story 95x235-ft. factory on Holmestead and Milnor Sts., to F. W. Van Loon, Perry Bldg. Estimated cost, $90,000.

PITTSBURGH—The Pittsburgh Forge & Iron Co., Chamber of Commerce Bldg., is receiving bids for the construction of a 2-story, 18x22 and 35x88-ft. coal mill building. Estimated cost, $40,000. Fuller Engr. Co., Allentown, engrs.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its 1920 convention and exhibit at Columbus, Ohio, the week of Oct. 4.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS is holding its one hundred and twenty-second meeting Aug. 20 to Sept. 3, on Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building, from Dec. 7 to 10 inclusive.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

THE CHEMICAL WARFARE POST of the American Legion will hold its next meeting Sept. 22, at 8 p.m., in the conference room of the Grand Central Palace, New York City.

ELECTRIC FURNACE ASSOCIATION will hold a meeting Oct. 6, at Columbus, Ohio, the subject of which will be "Refractories."

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.